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The Veterinary Record

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Complete Text of Papers and Discussions at the Seventy-sixth Annual Congress of the British Veterinary Association held at Douglas, Isle of Man, September 21st—26th, 1958

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Vol. 70 No. 49 Part Two Issue No. 4209 1003-1182 December 6th, 1958

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Metabolic Diseases of the Ruminant
1. In Relation to Husbandry

BY
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"METABOLISM may be defined as the chemical processes occurring within an organism or part thereof. They involve breaking down of organic compounds from complex to simple (catabolism) with liberation of energy available for the organism's many activities; and building up of organic compounds from simple to complex (anabolism) using energy liberated by catabolism and, in the case of autotrophic organisms, energy from external non-organic sources (particularly from sunlight). Catabolism is by no means confined to the breaking down of the 'food-material' necessary for the organism's energy requirements. It involves, continuously, all the constituents of the organism, though they are broken down at various rates; and correspondingly anabolism involves, continuously, synthesis of all the constituents. These processes go on even in an apparently static constituent, like bone, for instance. This metabolic whirlpool, whose all-embracing activity has become apparent only since the use of 'tracer' elements, is a system of reactions predominantly controlled by enzymes. In most of the aspects of metabolism which have been sufficiently investigated, such as catabolism of carbohydrates, there is a fundamental similarity throughout a wide variety of organisms, including plants, animals, and bacteria. Correspondingly, there are close similarities between the enzymes of these organisms." (Abercrombie *et al.*, 1951.)

It has become customary in veterinary literature to apply the term "metabolic" to a number of well recognised diseases, occurring mainly in cattle and sheep, in which abnormal changes can be demonstrated in the chemical composition of the blood. The use of the term in this restricted sense can only be justified if it is clearly understood that this is simply a matter of convenience and represents a stage in the history of diseases with a biochemical lesion, as it is likely that as time goes on the term will be applied to conditions not now included under this heading, if only because "metabolic disease" covers, by definition, derangement in any of the chemical processes occurring within an organism.

The following list includes the more common "metabolic" diseases—acetonaemia and pregnancy toxaemia, milk fever and lambing sickness, lactation tetany, grass tetany, and hypomagnesaemia in ewes. Phosphataemia appears less common but this may be more apparent than real simply because blood samples for this purpose are not so commonly taken as for some of the other disorders already mentioned. It would be generally agreed that these metabolic diseases have become of increasing importance in recent years, and it is our purpose to-day to examine some of them in relation to animal husbandry. The reasons for this increase are obscure, but it is commonly held that disorders of this type are associated with progressive farming methods. As little or nothing is known of the relationship between the incidence of metabolic disorders and the breeding of cattle and sheep, attention has been directed in this paper to the remaining branches of animal husbandry, namely feeding and general management. Some modern methods of feeding and management have been examined in an effort to see what responsibility they bear for the increase in the numbers of cases of metabolic diseases which has followed their widespread adoption.

The place that grass plays in the nutrition of the ruminant is of outstanding importance. In general, as a result of the work of Woodman at Cambridge and Fagan at Aberystwyth, it may be said that the nutritive value of herbage plants deteriorates as the plants mature, *i.e.* as the flowering and seeding stages are reached and the number of leaves is reduced. This reduction in feeding value takes the form of a fall in the protein content and a marked fall in the energy value, due mainly to an increase in the amount of fibre. Since 1930 the output from the grasslands of this country has increased, as a result mainly of the use of leafy strains of herbage plants and improvements in the management of pastures. These latter include alternate hard grazing and periodic resting and the use of artificial manures applied during the resting period. As a result the pasture is maintained in a leafy stage for as long as possible, so delaying the natural maturation of its constituent plants and the consequential deterioration in the nutritive value of the pastures by a reduction in protein and soluble carbohydrate. The use of leafy strains of herbage plants and improvement in grassland techniques has coincided with the adoption of a ley farming system in which such crops as rape, kale, Italian rye grass, and rye have been used to improve the quality of the diet of the farm stock during the summer and winter periods. Pastures are most productive in protein and supply the maximum amount of soluble carbohydrate in late May and June. Hay and silage, under modern conditions, are made as early in the year as possible, generally stimulated by the application of artificial manures, often containing nitrogen. This means that a product rich in crude protein and soluble carbohydrate is consumed *in situ*, and also conserved for winter feeding. There can be little doubt that these efforts to provide a diet relatively rich in protein and carbohydrate during both summer and winter have proved successful. Unfortunately early grass may be deficient in both calcium and magnesium. While it is true that neither hypocalcaemia nor hypomagnesaemia is a simple deficiency disease, this characteristic feature of immature herbage may be one of the reasons

why these disorders are so common on the more progressively conducted farms the most progressive modern farmer is he who gets his hay and silage early, containing lots of crude protein, soluble carbohydrate, and little fibre, but often short of calcium and magnesium.

The basis of soil fertility in this country and elsewhere is the legumes. As molybdenum is essential for the development of the nodules on the root systems of leguminous plants which are, in turn, responsible for the fixation of atmospheric nitrogen, and as clovers are encouraged in pastures by the application of phosphates to the soil, the grassland farmer did better than he knew when insisting on the particular value of basic slag for grassland. Objection to the use of nitrogen to pasture may be well founded; evidence is accumulating that the application of nitrogen, particularly in the form of sulphate of ammonia, depresses the uptake by the plants of both magnesium and copper.

The fact that clovers have been shown to be more effective than grass but not so effective as the so-called "herbs" in taking up copper and other trace elements from the soil is another reason for encouraging their presence in pasture. The total contribution made by clovers to the uptake of trace elements is far greater than that of the "herbs."

I want to follow these general remarks with a brief discussion of some of the more common metabolic disorders, pointing out certain things done by farmers which seem to play a part in causing signs of disease to appear.

Acetonaemia

In spite of much work, the cause of this syndrome is still not clear. In the author's limited experience it is most likely to appear on those farms of relatively low fertility which are well farmed by modern standards and where the cows are dependent to a marked degree upon home-grown food. It is common also under completely different conditions amongst cows producing heavily with the aid of purchased concentrates.

Pregnancy Toxaemia

One of the common names for this metabolic disorder gives a clue to the circumstances in which it occurs. "Snow blindness" is a most appropriate name as the disease is so often found in heavily pregnant ewes with their food supply suddenly cut off by a fall of snow. Such ewes are generally fat as the disease is common in lowland flocks under the conditions described. The practice of selling draft ewes from hill to lowland farms—a necessary, even essential, part of the hill farming system in Wales—is jeopardised by the losses which occur from pregnancy toxaemia amongst the hill ewes during the second year they spend on lowland farms. As a result of a general improvement in the diet of ewes throughout the whole year, it is difficult for farmers to ensure that their ewes are lean in the autumn. In fact, they are generally too fat in the autumn and it is difficult to prevent them becoming so as the lambs are weaned early and the food supply is good. In lowland flocks, where the problem of the too-fat ewe is important, it may be worth while thinking in terms of breeding twice a year. By selection within the flock and relatively early weaning this can be done and, in so doing, the size of the ewe flock can be reduced. It is essential to feed the pregnant ewe adequately in the latter half of pregnancy in an effort to prevent her losing weight. The practice of feeding hill ewes daily with a small amount of concentrated food during this period of pregnancy—a practice which is becoming more common—has everything to commend it.

Grass Tetany

This metabolic disease of cattle occurs in spring and summer. Blaxter and McGill (1956) have reviewed existing knowledge and the lines of research being followed in this country and abroad. It is worthy of note that collaborative work carried out at Reading (Bartlett, Brown, Foot, Rowland, Allcroft & Parr, 1954) contains a suggestion that sulphate of ammonia applied to pasture interferes in some way with the uptake of magnesium and predisposes grazing dairy cows to grass tetany.

Allcroft and Green (1938) when studying a group of outwintered cows, mainly of the Hereford breed, demonstrated a seasonal variation in the blood magnesium levels of these animals, which showed no clinical symptoms. They recorded the lowest levels during December. The same workers reported that they had previously been unable to detect any such significant seasonal variation in a herd of housed cattle. The diet of dairy cows contains a far greater proportion of home-produced food now than it did in 1934 when Allcroft and Green made their observations. As already stated, hay and silage conserved early in the season may be relatively short of calcium and magnesium and the diet of animals eating such products throughout the winter may consequently be short of these essential metabolites. Such animals turned out in the spring to modern pastures may be offered grass deficient in these elements at a time when their needs are high. It seems possible that the increase in incidence seen in recent years is associated with these changes in feeding and management which have occurred since 1934 when Allcroft and Green sampled the Reading dairy herd, and it may be that their work should be repeated.

Hypocalcaemia and Hypomagnesaemia in Sheep

The former disease of ewes has been recognised for many years. The classical disease is well recognised and responds to treatment with the injection of calcium. Hypomagnesaemia is not so well known. It occurs alone or in association with hypocalcaemia and often in similar circumstances, but it does not respond so well to treatment.

Unfortunately, very few blood samples are normally taken from acute clinical cases of metabolic diseases because of the need for urgent treatment and a desire by both veterinary surgeons and owners to reduce the distress of the animal to a minimum. The precise blood level at which clinical signs occur is not known. It is likely that this will vary, and there is considerable evidence that stress of some kind will precipitate the onset of signs. The sort of stress which acts in this way is transit either by sea, train, motor, or even walking considerable distances. It is possible that the effect of a particular

stress factor will vary from one ewe to another in a group all stressed in the same way; only a proportion will show clinical symptoms, some of those showing no symptoms may have lower blood levels than some of those that are obviously ill.

I intend to couple hypocalcaemia and hypomagnesaemia as they are often associated, although they may occur separately. Seasonal variations in blood calcium and magnesium do occur in sheep under certain environmental circumstances; ewes wintered on hill pastures have lower levels at the end of the winter than those wintered on the lowland (Hughes & Kershaw, 1958). In Wales disorders of this type are not uncommonly associated with the seasonal movement of the mountain ewe flocks from the high ground to lowland pastures in spring. The ewes are brought down in stages, the younger and weaker ewes come first; these may be brought down before Christmas and metabolic disturbances are not seen at this time. The time when the main flock is moved varies somewhat from year to year—the weather determines to a great extent when the movement actually occurs. After a hard winter when the ewes are relatively poor they come down earlier, but when the winter has been mild they can be left up on the hill longer. When this is possible the number of cases of metabolic disorders, including hypocalcaemia, is increased. Why should this be so? Under such conditions the differences between the diet of the hill ewes on the upland and that on the lowland where growth has commenced is greater than in a hard winter when no growth occurs on the lowland at this time. It is believed that this change to better pasture is connected with the onset of the disease, but it is difficult to see that the change in diet is the only important factor operating as often the symptoms come on very quickly after the movement has taken place and before the dietary changes can have had much effect. Under these conditions, where there is an increase in incidence in ewes kept longer on the hill, another important factor, surely, is that the ewes are more heavily pregnant and fail to stand up to the stress so well as they would have done if they had been moved earlier. Holding the flock for a time on a pasture intermediate in type between the hill and the lowland often prevents or reduces the incidence of this metabolic disturbance. May not the actual fact of allowing the animals a rest in this way, so reducing the stress, be quite as important as the reduction in the abruptness of the change in diet which this holding process provides?

The importance of abrupt changes in diet as a factor in the causation of metabolic disturbances should not be minimised, however. Hypomagnesaemia, either alone or in combination with hypocalcaemia, commonly follows the movement of ewes on to green cereal crops such as rye, wheat, or oats. The history of minor catastrophes of this type often includes a statement that the crop was dressed with artificial manures a short time before the ewes were moved on to it. The following incident is fairly typical. During the course of an investigation carried out during the spring of this year by one of my colleagues (Williams, 1958) it was discovered that losses from metabolic disorders were occurring in the ewes with twin lambs only. These had received preferential treatment, in line with common practice, taking the first pick of each change of pasture, etc., and they were the first to be placed on a crop of green wheat. Until this was done the number of deaths had caused little concern, but after a day's grazing on the wheat, a number of ewes died. The flock was removed and confined to the farmyard for a period of 10 to 12 hours. The combination of wheat and starvation resulted in the death of 18 ewes over the following period of 5 days. The results of the analyses of blood serum from 7 untreated ewes, none showing clinical symptoms, are set out in Table I:—

TABLE I

	Calcium	*Magnesium*	*Phosphorus*
1	10.3	1.0	3.4
2	10.0	1.3	3.3
3	9.7	1.5	—
4	10.3	1.7	4.3
5	7.8	0.8	2.5
6	9.3	1.5	4.1
7	9.5	1.8	4.7

It will be seen that the magnesium levels are rather low, two are less than half normal; one ewe has both a hypomagnesaemia and hypocalcaemia, and the inorganic phosphorus is somewhat depressed, but none showed any clinical symptoms. Why animals with these low levels remain apparently normal is not known. It is essential that they have peace and quiet, as if stressed in various ways many of them will begin to show clinical signs of a metabolic upset.

The causes of metabolic diseases are still obscure and answers to many questions are not yet available. This is not surprising as these diseases are complexities involving the whole organism, its food, and environment. Divergent views as to causation appear to be coming closer together, and it would be generally agreed now that nutrition and stress resulting in physiological dysfunction are important causal factors in many of them. New knowledge has made the picture clearer and clues are now available which will yield more information. Skill in herd and flock management is more necessary than ever, as the effect of stress in animals under modern farming conditions is very quickly seen and may be catastrophic. Methods of handling and management which reduce stresses of all kinds to a minimum should be employed under modern agricultural conditions in which animals are subjected to high metabolic turnovers.

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2. Vitamin D in Milk Fever in Cattle

BY

C. WEIGHTON

Lincoln

SUMMARY.—Milk fever is discussed from its earliest report in veterinary literature through the various stages of progress on aetiology, prevention and treatment. Whilst udder inflation was recognised as a decided advance in treatment, the discovery of a hypocalcaemia was a major approach towards a better understanding of the cause and led to more scientific methods of treatment.

Various methods of treatment and prevention are described. The major part of the paper is devoted to aetiology, the prophylactic effect of vitamin D feeding, and views on the action of vitamin D in maintaining a blood calcium level high enough to ward off an attack of milk fever.

The feeding of 15 million units of vitamin night and morning for 3 to 7 days pre-partum, *to cows which have previously been affected with milk fever has been shown to be an effective method of preventing the disease.*

Introduction

MILK fever was first reported in German literature at the beginning of the nineteenth century. In recent years, numerous publications have appeared, especially in American and British literature. The disease has become more prevalent as the result of selective breeding and feeding for high milk production. It occurs in all breeds of domestic cattle, but the incidence is probably highest in the Jersey breed.

The disease is usually seen 12 to 24 hours after parturition, is less frequent on the second and third day, and beyond that time is rare. It may, however, occur at any time unassociated with parturition. The average period which elapsed between parturition and the appearance of a clinical case of milk fever, in my own records of 73 cases, was 20 hours.

When the practitioner first attends a case the animal may still be on its feet, but a typical milk fever case quickly loses its ability to stand, and may soon show signs of losing consciousness.

A blood analysis shows, in all cases, a hypocalcaemia. The calcium level may in some cases be as low as 3 mg. per cent. serum. The average levels in my own cases comprising 73 cross-bred Lincoln Red shorthorn cows was serum calcium 4.7 mg. per cent. and serum magnesium 2.5 mg. per cent. (Normal values : calcium mg. 10 per cent. and magnesium mg. 2.5 per cent.)

There is usually a hypophosphataemia and a slight hypermagnesaemia. Milk fever (hypocalcaemia) must be differentiated from lactation tetany, and post-parturient paralysis (hypophosphataemia).

Atypical cases occur, and it may be difficult to place them in either the milk fever or lactation tetany category on clinical or biochemical grounds.

The most confusing cases appear to be associated with a seasonal hypomagnesaemia. In post-parturient paralysis cases there is a varying degree of paresis. The animal may make frequent attempts to rise or it may be unable to move from the position in which it is found, but will remain on its brisket throughout the illness which may be of 2 days' duration or longer. A blood analysis shows a hypophosphataemia although I have found from my cases that it is not so low as in the typical milk fever cases. The calcium level is normal and the cases fail to respond to calcium therapy.

History of the treatment and prevention of Milk Fever

a. General

Many theories as to aetiology of milk fever have been advanced, and long before the condition was shown to be faulty mineral metabolism various methods of treatment were practised. The early methods of treatment included the administration of stimulants, purges, cold water applications to the head, and chloral hydrate *per orem*.

With the object of destroying bacteria, which he thought were responsible for the disease, Schmidt in 1879 injected the udder with a solution of potassium iodide. This treatment was very successful and reduced the mortality from 60 to 70 per cent. to 15 per cent. Later, udder inflation was practised with air only and gave good results. Udder inflation with oxygen was believed to be more effective. By the inflation method, which was widely adopted, mortality was reduced to about 1 per cent. A disadvantage of the method is that the inflation must be carried out under aseptic conditions.

Theories as to the cause of milk fever have included: acidosis, alkalosis, hypoglycaemia, magnesium narcosis, hyperadrenalinaemia, hyper-functioning of the anterior pituitary, faulty protein metabolism, autointoxication, anaphylaxis and parathyroid deficiency.

Following the publication of the parathyroid deficiency theory by Dryerre & Greig (1925) preventive measures were adopted, such as parathyroid injections, dosing with calcium lactate and calcium chloride, and feeding cod liver oil.

Little (1933) was unable to prevent the decrease in blood calcium at parturition by feeding cod liver oil, although a slight beneficial effect was noticed. A greater percentage drop in diffusible calcium was observed at parturition than in total calcium.

Greig (1930b), discussing 82 consecutive cases of milk fever, stated that there was a marked serum calcium deficiency and a not unexpected fall in the blood inorganic phosphate.

It is well known that the drain of calcium from the

body for the production of colostrum is considerable, and Little & Wright (1926) showed that half a gallon of colostrum contains as much calcium as is present in the blood at any one time.

Greig (1930b), however, stated that the mere withdrawal of calcium from the blood as a result of the onset of a profuse secretion of milk could not in itself be regarded as the cause of milk fever, because, if this were so, every heavy milking cow would be subject to the disease.

He believed that the curative effect of mammary inflation is due (a) to stimulation of adrenal secretion and consequent oxidation of toxins and/or (b) to retardation of the formation of milk and the consequent prevention of further free exchanges of calcium from the blood to the milk. The preventive value of a restricted withdrawal of milk from the udder at calving was considered to be due to this procedure conserving the concentration of calcium in the blood.

Recovery following udder inflation was shown to take place if a calcium concentration of about 7 mg. per cent. serum was reached.

Further views on the aetiology and prevention of the disease have included those of Hibbs (1950) who, quoting Gotre, stressed the importance of mineral balance of the soil on which roughage is grown and suggested that the composition of the roughage and concentrates should be known, and balanced with supplements.

Hibbs refers to the work of Sjollema who points out that mineral deficiencies in the feed are the cause of such disorders as aphosphorosis, rickets, sterility and border-line conditions which only develop acutely when some other agent is operative. The same author emphasises the point that the drain on the blood calcium for the production of colostrum is not the primary cause of milk fever since, as shown by Hibbs, in normal parturition an equal drain on blood calcium and phosphorus for colostrum production is experienced which results in but a slight decrease in blood levels. He also states that it is more likely that the cause is the inability of the regulatory system to meet the sudden demand through mobilisation as suggested by Greig.

Owen (1954) conducted experiments on the effect of complete milking at calving on the incidence of milk fever and consequent effect on the cow and calf. He concluded that complete milking at calving has little effect on the incidence of milk fever.

Neidermeier and Smith (1950) found that different cows recovered at different blood calcium levels and suggest that the relative levels of calcium, phosphorus and magnesium may be more important in the symptomatology of milk fever than the level of any one constituent.

When there is a fall in the blood level of any one constituent one should concentrate on it alone by administering therapeutically the corresponding blood constituent. This procedure applies particularly to the typical milk fever case when it will be found that following the administration of calcium borogluconate a clinical recovery will be the result, and that eventually, although not necessarily immediately, the other constituents will return to normal subsequent to the return to normal of the calcium level. (Weighton, unpublished data.)

Hibbs (1950), writing on the blood magnesium levels as related to milk fever symptoms, observes that the anaesthetic effect of magnesium is due to the ratio of calcium to magnesium regardless of whether the serum calcium comes down to meet the magnesium as in milk fever, or when sodium oxalate is injected; or the serum magnesium goes up to meet the serum calcium, as when magnesium salts are injected. It seems reasonable to conclude that the relatively high serum magnesium accounts for the lack of tetanic symptoms in typical milk fever and the comatose condition which usually is seen in spite of the low calcium level.

A number of methods have been investigated in an attempt to prevent milk fever. Boda (1955) has conducted field trials on the influence of dietary calcium and phosphorus on the incidence of milk fever. His results indicate a lowered incidence of milk fever in cows fed a low calcium, high phosphorus diet for one month *pre-partum*. Sixty-eight cows were fed this diet; of these, 25 had previous histories of milk fever. The results were good, as only 5 cows showed slight clinical symptoms of milk fever.

Lewis and Burrow (1953) reported that the prophylactic administration of dihydrotachysterol to 4 cows given intramuscularly produced a rise in blood calcium levels which was maintained for about 4 days. A slower response was achieved from the oral route but the effect of an increased calcium level continued for a longer period.

The blood phosphate levels showed initial depression. From this they deduce that prophylactic substances which cause a phosphate depression may be contra-indicated in patients where hypophosphataemia and not hypocalcaemia is the chief cause of recumbency, unless phosphates are administered concurrently.

They conclude that the constant elevation of blood calcium levels after the administration of dihydrotachysterol suggests that it has a therapeutic indication in potential cases of hypocalcaemia as a means of retarding the development of the condition and in preventing relapses after initial treatment. The action of dihydrotachysterol is similar to that of parathyroid extract, but the latter causes a rapid rise in blood calcium, reaching a peak within a few hours, and then subsiding completely in a day or two. In the case of dihydrotachysterol the rise in blood calcium is slower and takes place 24 to 36 hours after intramuscular injection.

Last summer 3 cows were injected (Weighton 1957) with 10 ml. dihydrotachysterol each as a prophylactic measure. All the cows had previous histories of milk fever. The chemical data at the time of the injection in the first case, a nine-year-old Friesian, were: serum calcium 8.1 mg. per cent., serum magnesium 2.8 mg. per cent., blood inorganic phosphate 2.1 mg. per cent. The cow calved 2½ hours later and had a milk fever attack 21 hours after the injection. The blood data were then 4.3, 3.2 and 1.1.

The second cow, also a Friesian, received a pro-

phylactic injection intramuscularly at 9.40 p.m. This cow was down with milk fever next morning by 8 o'clock. The third case, an Ayrshire, was treated at 1 p.m. The cow calved 8 hours later, and made satisfactory progress.

These cases illustrate the difficulty of predicting the time of parturition and also show that a reasonable time must elapse before any prophylactic effect can be expected.

Greig (1930a) suggested the administration of calcium borogluconate by subcutaneous injection immediately after parturition and again about 24 hours later as a probable method of preventing an attack of milk fever.

Most satisfactory results by this method have followed the administration of a calcium borogluconate solution containing 90 to 120 g. about 3 to 4 hours after parturition, the object being to give the calcium at or about the time that the calcium regulatory mechanism loses control. (Weighton 1957.)

Relapses in milk fever are quite common and the following description is typical (Weighton 1956). A six-year-old Friesian-cross cow which calved at 3 a.m. on 27.9.56 had a milk fever attack at 6 p.m. on 28.9.56, 39 hours after calving. Treatment consisted of 120 g. calcium borogluconate intravenously and 120 g. subcutaneously. The cow was up in 5 minutes. She had a relapse on the morning of 30.9.56 and at 5.30 received the same treatment as before, again responding in 5 minutes. The blood data at the first attack were serum calcium 3.1 mg. per cent., serum magnesium 2.5 mg. per cent. and blood inorganic phosphate 1.4 per cent.

It would appear that a large dose of calcium does not prevent a relapse. A few clinically similar cases seen about that time also relapsed.

This case shows that a good result can be achieved from calcium alone, in spite of the low phosphate. The absence of phosphate from the therapeutic dose is unlikely to have any bearing on a relapse otherwise more cows would go down a second time. In my view, its inclusion in the therapeutic injection for typical milk fever cases serves no useful purpose.

b. Vitamin D in Milk Fever

Although it is only within the last few years that the value of vitamin D has been appreciated as a means of preventing milk fever, Russell Greig, Sjollema, and Little and Mattick all suggested that vitamin D might prove beneficial in this connection.

Greig (1930a) gives interesting details of probably the first experiment on the feeding of vitamin D as a means of preventing milk fever. Commencing 124 days before parturition serum calcium levels were determined at intervals from a cow which had had 7 previous attacks of milk fever. During a period of 69 days before the feeding of vitamin D was commenced the average calcium level was 8.59 mg. per cent. serum.

Vitamin D was then fed for 20 days. The average serum calcium level for this period was 10.52 mg. per cent., which can be accepted as at the upper range for serum calcium in the normal cow. As soon as the vitamin D feeding was stopped there was an immediate fall in the serum calcium level.

From this time for another 35 days, till the date of parturition, the serum calcium fluctuated within the normal range, but the average of 9.27 mg. per cent. was below the level prevailing at the time of the vitamin D feeding.

The cow calved at 8 a.m. and appeared to be well until the next morning at 7.30 when the onset of milk fever was observed. The cow went down and typical somnolence developed, although the case was regarded as mild in type. The cow continued in this condition throughout the evening and night, but by 6.30 a.m. next morning she had made a spontaneous recovery without any treatment having been applied. Vitamin D has long been known to be associated with the metabolism of calcium and phosphorus and Hibbs & Pounden (1953) in the United States have pursued extensive trials with vitamin D for a number of years.

Their original work showed that no reduction in milk fever incidence was obtained from feeding from 1 to 5 million units of vitamin D daily for from 2 to 4 weeks *pre partum*, and may have been due to suppression of parathyroid activity resulting from prolonged feeding of vitamin D. They later decided that large doses for short periods would provide the maximum supplemental action without possible parathyroid suppression due to prolonged elevated blood calcium.

Campbell and Turner (quoted by Hibbs) showed that vitamin D administration causes a decrease in the animal's own parathyroid activity when fed for long periods. In other words, there is a strong tendency for the animal to maintain a normal calcium level, and if this is accomplished with supplemental vitamin D or high calcium rations then the cow's own parathyroid glands are not needed and lapse into a hypo-active state. If fed over a long period, therefore, the effect is nullified.

The later trials by Hibbs & Pounden (1955) consisted of the feeding of large doses of vitamin D for 5 to 7 days before parturition. One of the problems of this method was in predicting the calving date so that vitamin D feeding could be properly timed.

Table I gives the results of the vitamin D feeding in the 1953 trial in which all the cows had previous histories of milk fever.

TABLE I

Vitamin D Million units fed per day	Number of cows fed	Number of milk fever cases
0	17	9
10	10	1
20	4	0
30	10	0

Work at the Ohio Agriculture Station has indicated that by feeding the massive dosage mentioned, blood calcium and phosphorus levels maintain a higher than normal level through the critical period after calving.

The result of further trials by the same authors were published in 1955.

They used two sources of vitamin D

(a) Irradiated dry yeast;

(b) Viosterol (irradiated ergosterol).

The vitamin D was fed in silage, or, in the case of viosterol, administered *per orem*. Only cows which received vitamin D from 3 to 8 days were included. All cows were milked out as completely as possible at the first milking after parturition.

The effect of the various amounts of vitamin D on milk fever incidence was noted. These quantities ranged from 5 million units to 30 million units per day and their results are given in Table II.

TABLE II

Million Units	Number of Parturitions	Number with milk fever at previous parturitions	Number of milk fever cases	Percentage incidence of milk fever
30	10	10	0	—
20	4	4	0	—
10	12	7	1	8
5	5	2	1	20
Control No vitamin D	50	0	27	54

Both sources of vitamin D appeared equally effective.

In the two groups which were fed 30 and 20 million units all the cows had previously had milk fever and in these groups no milk fever cases occurred.

The results were not so good in the 10 million and 5 million groups, and in the control group 27 cows out of 50 had milk fever.

In the autumn of 1957 Dr. R. Allcroft asked me to participate in the field trials which were being put in operation from Weybridge. I was pleased to have the opportunity of taking part and was fortunate in having the histories of a few of my 1956 milk fever cases.

The object of this trial was to confirm the work of Hibbs & Pulden on the prophylactic value of vitamin D.

Materials and Methods for Vitamin D Trials

The 8 cases comprised 2 Lincoln Red, 2 Ayrshires (both on the same farm), 3 Friesians and 1 Friesian cross. All had been affected with milk fever at their previous parturitions.

Vitamin D was given in the food for 7 days previous to the expected date of parturition. However, in Case No. 1 the dispersible vitamin D powder was given in water *per orem*. The feeding was at a level of 15 million units of vitamin D night and morning.

The methods followed were those of Hibbs & Pulden (1955), except that there was a slight difference in the times of blood sampling. Blood samples were taken first, at the commencement of the feeding of vitamin D, next at calving, and a third 24 hours after calving.

It was considered inadvisable to extend the feeding of vitamin D for longer than 7 days, but if the animal calved on the sixth day of feeding, it was given the remaining dose of vitamin D.

Results

Case No. 1

A seven-year-old Lincoln Red cow received vitamin D from the morning of the 27.9.57 until the morning of 5.10.57. The cow calved at 6.30 a.m. on the 6.10.57, about 24 hours after the last dose of vitamin D. She had been at pasture night and day until parturition. No mineral supplement had been fed since May. Blood samples were collected at 11 a.m. on the 27.9.57, 11.30 a.m. on the 6.10.57 (5 hours after parturition), and at 3 p.m. on 7.10.57.

The serum calcium level remained above 10 mg. per cent. throughout, the last sample registering 0.4 mg. per cent. above the initial sample. The magnesium level was normal in the first 2 samples and dropped to 1.5 mg. per cent. serum in the third. There was a rise in inorganic phosphate from 4.3 to 6.8 mg. per cent. blood. The acetone levels were normal. The response to vitamin D was good.

Case No. 2

A seven-year-old Ayrshire cow received vitamin D from 6 p.m. on 13.10.57 until the morning of 15.10.57, consuming a total of 75 million units. The cow calved at 11 a.m. on 15.10.57. Blood samples were collected at 11 a.m. on the 13.10.57, 10.30 a.m. on the 16.10.57 and at 11.30 on 20.10.57. The serum calcium levels were 9.8, 7.5 and 8.8 mg. per cent. The second sample showed a mild hypocalcaemia 36 hours after calving which was almost within the milk fever range (2-7 mg. per cent. serum). There was a slight rise in inorganic phosphate from 4.7 to 5.3 mg. per cent. blood. The other values were normal.

The cow consumed 5 doses only (75 million units) before calving, but vitamin feeding was continued till 20.10.57. The cow was receiving winter rations. It would appear that an attack had just been averted.

Case No. 3

An Ayrshire cow, received vitamin D from the morning of the 14.10.57, a few hours before the first blood samples were collected, until 6 a.m. on 20.10.57.

The cow calved during the night of 21st/22nd. The serum calcium levels were 10.1, 8.9 and 9.6 mg. per cent. and thus kept within the normal range. Magnesium, phosphate and acetone levels were normal. The highest inorganic P level was found just after the parturition and the third sample showed a level below that of the initial sample. The result was again satisfactory.

Case No. 4

A Friesian-cross had an attack of milk fever 5 days after consuming the last dose of the 7-day course of vitamin D. This cow had relapsed following calcium therapy for milk fever at the previous parturition. The usual blood samples were collected; the serum calcium levels were 10.8, 7.0 (at parturition), and 5.3 (milk fever) mg. per cent. serum. The magnesium levels were 2.4, 2.6 and 2.1 mg. per cent. serum. The acetone was normal. The inorganic

phosphate levels were 3.9, 1.9 and 1.0 mg. per cent. blood.

The period between the end of the vitamin D feeding and the time of parturition was evidently too long for the vitamin D to maintain a calcaemic action.

The cow was up within 3 minutes of receiving calcium borogluconate subcutaneously and intravenously. A subcutaneous injection of 120 g. calcium borogluconate was given the following day although the cow was then clinically normal.

Case No. 5

A 10-year-old Friesian with a history of milk fever at the previous three or four parturitions. The cow was on winter rations in which she was fed vitamin D from December 6th to December 13th.

Only two blood samples were collected, one at the beginning of the vitamin D feeding and one nine hours after calving. The serum calcium levels were 9.6 and 11.5 mg. per cent., the serum magnesium was 2.5 and 1.6 mg. per cent. The acetone readings were normal and the inorganic phosphate 4.1 and 7.4 mg. per cent. blood, thus showing a rise as in Cases 1 and 2. This case showed no symptoms of milk fever and in view of her history the result was good.

Case No. 6

A ten-year-old Friesian had milk fever for the first time in April, 1957. She responded in 10 minutes to calcium borogluconate, 60 g. intravenously and 60 g. subcutaneously.

When prophylactic treatment was started the cow was at pasture and was receiving no special rations or minerals. Vitamin D was fed from June 4th for 7 days. The cow calved at 7 p.m. on the 10th, 3 days before her due date. Blood samples were obtained on June 4th, 11th (16 hours after parturition), and 24 hours later.

The serum calcium levels were 9.4, 7.4 and 6.4. There was a slight hypocalcaemia in the second sample and the third reading was within the milk fever range. The inorganic phosphate levels were 5.1, 3.4 and 2.0, thus showing an appreciable fall in both samples *post-partum*. The magnesium levels were about normal, and the acetone values were normal. No attack occurred.

Case No. 7

A ten-year-old Friesian had an attack in 1956 and again in 1957. It responded to calcium therapy. This year the cow was again at pasture and was fed vitamin D from June 9th for 6 days.

An additional 30 million units were fed, one dose on the 17th and one on the 18th. The cow was 8 days overdue when she calved on June 26th and had received no vitamin D for 8 days.

Blood samples were collected on June 9th, June 26th (one hour after calving) and the 27th, when the serum calcium values were 10.1, 8.2 and 6.8. The last sample taken 24 hours *post-partum* was within the milk-fever range. The magnesium values were about normal, and the acetone values were normal. The inorganic phosphate values were 4.2, 3.5 and 3.2, thus showing a fall. The result proved satisfactory.

Case No. 8

An eight-year-old Lincoln Red cow had milk fever in May, 1957, and was up 4½ hours after calcium therapy. The cow was at pasture and received vitamin D from June 17th for 11 days. Two additional doses were fed.

Blood samples were collected on June 17th, 28th (7 hours *post-partum*) and 24 hours later. The serum calcium values were 9.6, 8.1 and 9.2, the magnesium values were 2.7, 2.8 and 2.2. The acetone values were normal. The inorganic phosphate value had increased from 3.7 to 6.1 at the time of taking the second samples 7 hours after calving.

In this case the vitamin D was fed for 11 days up to the date of calving. Smaller quantities of vitamin D were given in order to cover the whole period *pre-partum*. The result was good.

In 7 cases the feeding of vitamin D has been most satisfactory and the trial is being continued. Case No. 4 had milk-fever.

Discussion

It has been established, experimentally in a number of species, that vitamin D increases the absorption of calcium and phosphorus. It has been shown that, in cattle, there is a marked diminution of calcium absorption with increased age and the characteristic occurrence of milk fever in aged cows, as opposed to young cows, suggests that the efficiency of calcium absorption and mobilisation is involved as a major contributory factor in the onset of milk fever. It has also been shown that aged cows which develop milk fever are in severe negative calcium balance for 15 days *pre-partum*.

Robertson, *et al.* (1956) in the course of their investigations into the aetiology of milk fever showed that in normal cows there is an appreciable fall in blood calcium *post-partum*, which shows a higher percentage fall with each subsequent calving. A fall of 11 per cent. for a first calver may reach a 30 per cent. figure at the fourth calving. These workers confirmed a corresponding fall in phosphate and a rise in magnesium.

Their *pre-partum* milking trials suggests that the blood is depleted by the demands of lactation. They found no evidence that cows which take milk fever secrete more colostrum than those which do not, nor was there any suggestion that their colostrum contains more calcium.

The authors conclude that the milk fever cows are less well able to mobilise their reserves or that they have less reserves to mobilise. The results suggest that the mechanisms controlling the mobilisation of calcium become less effective with each successive parturition, and that a point is reached, usually after the third and subsequent parturitions, when in a proportion of animals the mechanisms fail to counteract the fall in blood calcium resulting from the onset of lactation, to such an extent that clinical milk fever ensues.

They also state that it would seem likely that successful calcium therapy by inducing a temporary rise in the blood level abolishes the clinical signs for long enough to allow the calcium regulating mechanisms time for the mobilisation of calcium from the body reserves and re-establishment of normal levels. They believe that in milk fever the calcium-regulating mechanisms are essentially normal and that the basic

cause of the disease is the inability of that normal mechanism to mobilise calcium sufficiently quickly from the osseous tissue to meet the demands.

They were able to show from studying the blood levels of 3 cows which had had their udders removed, and comparing them with samples from 3 normal cows, that the drain of calcium into the colostrum is a major factor in producing the lowered blood calcium in normal cows at parturition.

American writers believe that of the many theories advanced as to the cause of milk fever the parathyroid deficiency theory of Greig comes closest to explaining this metabolic disturbance.

According to this theory, the abnormally great decrease in blood calcium at calving is caused by a deficiency of the parathyroid glands. The onset of the profuse secretion of milk causes a sudden withdrawal of calcium from the blood to the milk. This loss is normally replaced through the blood calcium regulatory action of the parathyroids. When this regulation fails to take place rapidly enough milk fever may develop.

The indications are that in milk fever the failure to mobilise calcium from the skeletal reserves may be due either to a failure of the parathyroid glands to secrete sufficient hormone or to a situation in which sufficient is secreted, but it is rendered temporarily inactive by some metabolic condition in the tissues at parturition.

To continue their observations on the effect of vitamin D they believe that the relatively high blood calcium level maintained during the critical *post-partum* period is the cause of, or at least an indicator of, the protection against milk fever. However, the mode of action of vitamin D, in eliciting increased blood calcium, is not well understood.

The extremely low parathyroid activity, the increased gland size, and the histological changes in the parathyroid glands of cattle fed massive doses of vitamin D compared with controls, indicated that the observed increase in blood calcium was not due to parathyroid stimulation, but may have been caused by increased intestinal absorption, lowered intestinal excretion, or some direct effect on calcium mobilisation from the skeletal resources. Thus the calcaemic effect of massive doses of vitamin D may be the result of a parathyroid replacement action which provides for the maintenance of the higher than normal blood calcium levels during the critical *post-partum* period despite the hypo-parathyroid function resulting from the vitamin D feeding. Other workers believe that the calcaemic action of vitamin D can be attributed to its stimulating effect directly on parathyroid tissue.

The marked increase in serum phosphorus at these high levels of vitamin D feeding, although apparently not directly concerned with milk fever prevention, may be indicative of the parathyroid depressing effects of the vitamin D.

Other possible causes of the increased phosphorus level are mobilisation from the skeletal reserves or some alteration in the intestinal absorption or excretion. Recent studies (Conrad *et al.*, 1955) with radioisotopes have shown that massive doses of vitamin D increases calcium and phosphorus absorption from the digestive tract.

It is evident from the work cited above and the case histories recorded herein that the feeding of 15 million units of vitamin D night and morning for 3 and preferably not more than 7 days *pre-partum* to cows which have previously been affected with milk fever, has proved to be an effective method of preventing the disease. Further work will, no doubt, reveal the mode of action of vitamin D in these cases.

Acknowledgments.—I wish to thank Dr. R. Allcroft of the Biochemical Laboratory, Ministry of Agriculture, Weybridge, for her valuable help. Miss O. Uvarov, Glaxo Laboratories Ltd., Greenford, for kindly supplying the vitamin D, and for her advice regarding its feeding and suggestions relating to the field trial.

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Ketosis in the Ruminant

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SUMMARY.—The paper commences by defining the term "Ketosis" and enumerating the diseases in which ketosis is a characteristic feature. The origin of the ketone bodies is then discussed. The important influence of the metabolism of the individual *animal is stressed and the factors which may induce a ketonaemia are considered to fall into two main groups, nutritional and endocrine.*

The influence of nutrition is considered firstly by reference to the circumstances under which pregnancy toxaemia in the ewe and acetonaemia in the cow occur. The increasing nutritional requirement in later pregnancy in the ewe and early lactation in the cow is emphasised. The effects of experimental fasting in advanced gestation in the ewe and cow and in the immediate post-parturient period in the cow are considered and compared with the natural diseases in the two species.

The influence of disturbance in the endocrine equilibrium as an aetiological factor in ruminant ketosis is considered, reference being made to the haematology, histopathology and biochemistry of clinical cases.

The symptoms are briefly described and an attempt is made to correlate symptoms with lesions, particularly in the ewe.

Diagnostic methods are briefly discussed, including conditions to be considered in differential diagnosis.

Preventive measures are considered in some detail, particularly in relation to nutritional requirements in both the ewe and the cow. Suggestions are included for further work on both the nutritional and hormonal aspects of the disease.

Finally, current methods of treatment are briefly summarised.

THE condition of ketosis implies the accumulation of ketone bodies—acetone, aceto-acetic acid and beta-hydroxybutyric acid in the blood, resulting in their excretion in the urine and milk. These substances, being volatile, are also excreted by the lungs and produce a characteristic sickly-sweet odour in the breath.

In ruminants ketosis is encountered as a characteristic clinical feature in the syndrome termed ketosis or acetonaemia in the lactating cow and pregnancy toxaemia in the ewe and goat, and occasionally in the cow. In other domestic species ketosis is rare except in the dog in which it occurs most commonly in uncontrolled diabetes mellitus.

The Origin of the Ketone Bodies

Ketone bodies are normal intermediate products of fat breakdown for energy purposes. Soskin & Levine (1946) state: "when ketosis occurs in the living organism, it may be regarded, for practical purposes, as an index of the catabolism of fat." It is therefore under conditions in which the animal has to utilise fat that these substances accumulate, presumably due to excessive fat breakdown and thus overproduction of these intermediate products. Their accumulation does not necessarily imply any interference with utilisation. The body's fat reserves exist as a storehouse of energy for use in emergency. Under normal conditions of nutrition when food intake is adequate in quantity and quality, carbohydrate is the major source of readily available energy. Excess above immediate needs will be stored as glycogen and any extra is stored as fat. It is therefore under conditions in which food supplies are inadequate in quantity and/or quality in relation to requirements, or when metabolism, particularly of carbohydrate, is interfered with due to hormone imbalance (as in diabetes mellitus in the dog) that ketosis tends to develop.

Thus an accumulation of ketone bodies in the blood, urine, milk and breath is often only one symptom, not necessarily a syndrome *per se*, and an increase in the body's production of ketones may occur in a wide variety of diseases, particularly if they are associated with anorexia and production is maintained even if only temporarily. It is, however, such a characteristic feature in a well-recognised syndrome in the immediate post-parturient period in the cow (1 to 6 weeks after calving) as to justify the recognition of a typical disease termed ketosis, and it is a definite feature in pregnancy toxaemia in the ewe.

The kidneys tend to concentrate ketone bodies and thus a ketonuria is usually the first sign of disturbed metabolism. Hence ketonuria may occur in some cases of traumatic reticulitis in cattle or retained placenta, and it may also appear as a complication in other metabolic diseases such as milk fever and hypomagnesaemia. Generally, however, the degree of ketonaemia is not so great as in the typical ketosis syndrome.

The digestive processes peculiar to the ruminant also tend to render it more susceptible to ketosis. Instead of being broken down by enzymic digestion to simple sugar, all ingested carbohydrate in the ruminant is first subjected to bacterial fermentation in the forestomachs with the production of lower volatile fatty acids some of which are ketogenic. Knodt, Shaw & White (1942) observed a gradual rise in ketone bodies in normal calves which paralleled the development of the rumen. This was accompanied by a fall in blood glucose as the animal slowly changed from milk food to a herbivorous diet. In the normal adult ruminant the blood level of ketones is slightly higher than in the single-stomached animal.

Typically ketosis is accompanied by a fall in liver glycogen and an increase in liver lipids. In ruminants the blood sugar level is variable but in the majority of cases it tends to be low.

Factors which may Induce a Ketonaemia

Fundamentally the aetiological agents which may induce ketosis may be grouped under two headings, nutritional and endocrine (Fig. 1).

The nutritional factors which may induce ketosis include, firstly, inadequate feeding in relation to nutritional requirements. This may be due to an obvious insufficiency of dietary nutrients which would be particularly liable to induce ketosis during pregnancy. In the post-parturient lactating animal a gross nutritional deficiency may be less severe in its effects because the production of milk, which is the prime drain on food intake, will usually be promptly reduced in response to inadequate feeding. It may be, therefore, that the cows which develop ketosis are those in which the milk producing ability is such that production is maintained or even increased despite an inadequate food intake. This may have some relation to genetic tendencies relative to production potential (the results of selection for high production), and endocrine factors related to milk production may also be concerned.

The use of unsuitable food may be a factor, either by failing to provide adequate calories or by inducing digestive upsets in the animal. The high producing cow which requires a heavy concentrate feed to balance production demands may suffer from digestive disturbance due to inadequate roughage in the diet. The high yielding animal may present the added problem that it may be physically impossible to provide sufficient food by mouth to balance the drain occasioned by high milk yield.

It would seem that of the dietary constituents concerned, carbohydrate, being a day-to-day source of energy, will be of particular importance in the diet. The fatty acids produced by ruminant digestion, however, reduce the effectiveness of carbohydrate as an antiketogenic agent when compared with its value in monogastric animals, where the end-product of digestion is simple hexose. Protein may also be important, particularly in the pregnant ewe in which there are considerable protein demands for foetal development.

The endocrine concept as an aetiological factor in the disease is fascinating but not so clear-cut as the effect of nutrition. Normality represents the results of a balance between opposing hormones. Soskin & Levine (1946) indicate the importance of the liver in the endocrine regulation of the blood sugar level. They represent the liver as being at the centre of a

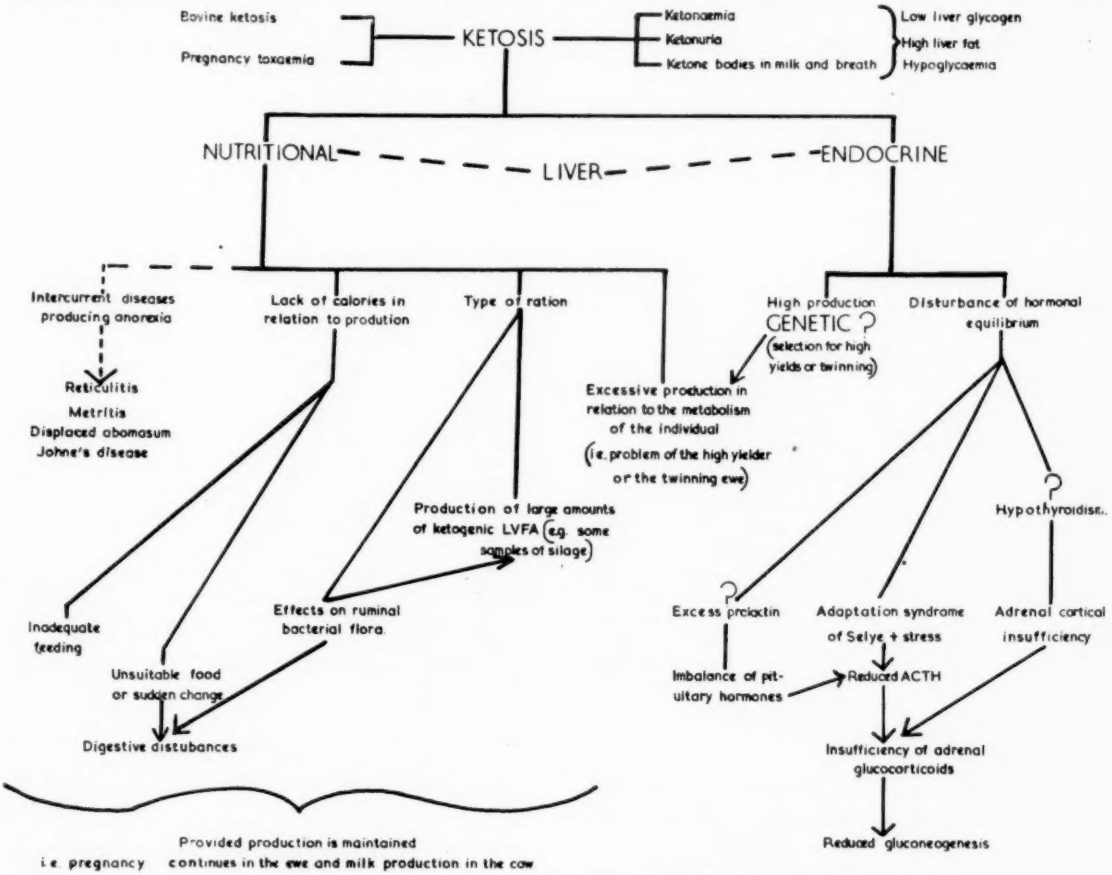


FIG. 1.—An outline of some aetiological factors in ruminant ketosis.

hormone balance between insulin production from the pancreas favouring hypoglycaemia on one side, and the anterior pituitary and indirectly the thyroid and adrenal cortex tending to produce hyperglycaemia on the other side. A disturbance may, therefore, result either from an insufficiency of one hormone or an excess of its opposing hormone. Thus hypoglycaemia could result from excess insulin or insufficient anterior pituitary hormone or thyroid or adreno-cortical insufficiency, or a combination of these factors. The endocrines to which present attention are particularly directed in ruminant ketosis are the anterior pituitary and the adrenal cortex.

The importance of the function of the liver itself in the regulation of the blood sugar level must also be considered. Liver disease has generally to be very extensive before disturbance of function occurs. It has been shown (Holmes, 1951) that intravenous glucose tolerance in cows with ketosis is normal. Furthermore, the histological findings in the liver in pregnancy toxaemia in the ewe are really "exaggerated physiological changes" and if the animal recovers the liver histology returns completely to normal. These observations suggest that in ketosis the liver is probably involved indirectly.

There are undoubtedly close interrelationships between the nutritional and endocrine factors. For example, dietary insufficiency causing liver glycogen depletion and fatty infiltration, by affecting the liver's blood sugar regulating mechanism will affect the endocrine balance. In the opposite way the effect of adrenal insufficiency by reducing gluconeogenesis may thus deplete carbohydrate stores and induce liver fatty infiltration. The liver may, therefore, be regarded as the central focus in carbohydrate metabolism and it is affected whether the primary aetiological factor is nutritional or endocrine.

Thus it is evident that more than one cause may operate to produce ketosis, that is, the aetiology in different cases may be different although clinically the effect will be the same—the production of ketone bodies in excess with depletion of carbohydrate stores and infiltration of fat into the liver.

All the metabolic diseases are diseases of individual animals, and whilst at times they may assume the appearance of herd or flock problems they really represent the reaction of individual animals to stress of nutritional or endocrine origin. Thus, for example, ketosis in the cow is not necessarily seen in the highest yielder in a herd, for a yield of 500 gallons may be as great a stress to one cow as a yield of 1,000 gallons to another. It is the metabolism of the individual animal which governs the animal's susceptibility within its environment. In this respect, therefore, the thyroid—and through the thyroid the basal metabolic rate—may be important factors in affecting the susceptibility of ruminants to ketosis.

Nutritional Aspects

Conditions of occurrence of ketosis in the cow and ewe

A study of the conditions under which ketosis occurs is of value in further consideration of the aetiology of the disease in these two species. The factors which appear to be concerned may be tabulated as follows:

Ewe (Pregnancy Toxaemia)

Rare in gimmers. Generally from 2nd pregnancy onwards. (Dayus & Weighton, 1931; Holmes, 1953.)

Ewes pregnant with twins or triplets.

Advanced pregnancy. Generally from 16th week onwards.

Often following very severe weather, heavy, prolonged snowfalls, etc.

Recovery generally only after parturition, otherwise mortality high—90 per cent.

Cow (Ketosis)

Generally in 3rd calvers onwards and very rare in heifers (1st calvers).

Individual predisposition evident in that same cow may be affected at succeeding calvings particularly if she calves in winter or early spring.

Generally at 1 to 6 weeks after calving when milk yield rising to peak.

Winter calvers particularly. (Highest incidence December to March.)

Mortality from uncomplicated ketosis virtually nil.

Pregnancy toxaemia in the ewe particularly affects ewes pregnant with twins or triplets, and it is thus commonly known as twin lamb disease. It may occasionally occur in ewes carrying single lambs, and the writer has seen such cases in ewes with severe foot-rot in which presumably the interference with nutrition by reduction in grazing was the factor concerned. Pregnancy toxaemia, therefore, is more commonly encountered in lowland flocks where the incidence of twinning is high, and lambing early in the year increases the risks of bad weather such as heavy snowfalls occurring during the latter part of the gestation period. Ketosis is, however, sometimes seen in hill flocks, particularly after severe and prolonged snowfalls, and in these animals the resulting syndrome is a straightforward starvation ketosis. Fundamentally, the aetiology is probably the same in both hill and lowland ewes, but in the latter pregnancy toxaemia is often encountered in animals in relatively good condition.

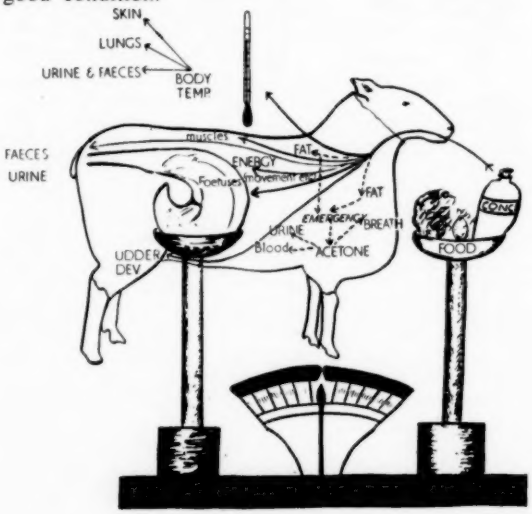


FIG. 2.—The nutritional balance in the pregnant ewe.

The disease appears in advanced pregnancy and is not usually encountered before the 16th or 17th week. It does not occur after parturition. The incidence on a farm or in an area may vary from year to year depending on weather conditions and time of lambing, for flocks which lamb later in the season may be less susceptible as advanced pregnancy may then coincide with improving natural food supplies.

All these facts, plus the observation that recovery generally only follows parturition, and also that the disease can be experimentally reproduced by fasting in late gestation, suggest that inadequate food supplies during advancing pregnancy may be very important in inducing the disease.

The syndrome may thus be regarded as the result of a negative nutritive balance which begins to appear probably towards mid-pregnancy and becomes more severe as gestation progresses. The condition may be likened to a balance between food intake and food requirements as illustrated in Fig. 2. Food nutrients are utilised for energy required for movement, the maintenance of body temperature, and are lost through the urine and faeces. At the same time udder development is commencing and there is an increasing requirement for foetal growth. This becomes particularly important in the latter third of pregnancy (Hammond, 1948) which often coincides with a time when natural food supplies are diminishing. Wallace (1948) from experiments on the effect of low and high planes of nutrition on pregnant ewes, observed that on an inadequate diet the gravid uterus continues to grow " not only at the expense of the mother's accumulated reserves, but even when her vital structures are being depleted and she is reduced to a state of extreme exhaustion." Under these circumstances fat is mobilised to make good the nutritional deficit and in consequence a ketosis develops. It is also noteworthy that in many cases of pregnancy toxaemia mammary development is retarded, in fact an assessment of the proximity of parturition on the basis of udder enlargement can be quite erroneous in cases of this disease.

As further support for the hypothesis that pregnancy toxaemia may be the result of an imbalance between food intake and foetal demands it is well recognised that a fall in bodyweight is a prodromal symptom of the disease. Any disturbance in nutrition during pregnancy due to bad weather, poor pasture or reduction in grazing from foot-rot, rapidly results in a loss in bodyweight and these ewes are particularly susceptible. Observations on the weekly weight changes of a flock of ewes kept under ordinary lowland farm conditions during the latter part of pregnancy are shown in Fig. 3. It would seem desirable that ewes should show a steady weight gain as pregnancy advances for the uterus and its contained foetuses is gaining in weight. Thus, if bodyweight of the animal remains constant, the ewe herself is actually losing weight. Fig. 3 shows the striking effect of concentrate supplementation on bodyweight gains.

Comparison of Pregnancy Toxaemia in the ewe and Ketosis in the cow

Wright (1950) observed that pregnancy toxaemia is not often diagnosed in the bovine animal, but cases are occasionally encountered, usually in cows in late pregnancy carrying twins, which are characterised by ketosis and symptoms not dissimilar from pregnancy toxaemia in the ewe. This condition in the cow may prove fatal. The incidence is probably low largely because of the low incidence of twinning in cattle compared with sheep, and the fact that generally the nutrition of the pregnant cow is better than that of the ewe.

It is interesting to consider why the ewe should develop ketosis during pregnancy and the cow in early lactation. The difference is probably determined largely by the nutritional requirements of the two species. The disease in the ewe is closely associated with the presence of multiple foetuses, and whilst their total weight in relation to the weight of the mother may be no greater than that of a single calf in relation to its dam, it would appear that the nutritional demands of 2 foetuses, however small they may be individually, are greater than the requirements of a single large foetus. When lactation commences the nutritional drain on the cow (which may be enhanced genetically through selection for high yields) is greater than in the lactating ewe. Thus ketosis develops during pregnancy in sheep and lactation in cattle. The nutritional aspect of ketosis in cattle may therefore be represented by a balance (Fig. 4) as in the ewe (Fig. 2) but in the cow it is a balance between food intake and milk output.

In pregnancy toxaemia the mortality is high, often in the region of 90 per cent. of affected animals, whereas in cattle uncomplicated ketosis is very rarely

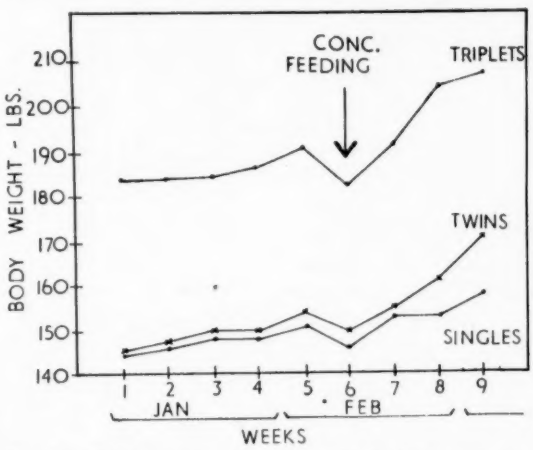


FIG. 3.—Weight changes in the last third of pregnancy in a lowland flock. No supplements were fed until the second week in February when concentrate feeding commenced.

fatal. The explanation for this may be that the ewe is unable to restore the intake-output balance as long as pregnancy continues, whereas the cow largely corrects the imbalance herself, simply by reducing milk yield.

Subclinical ketosis

Eden & Green (1940) described seasonal ketonaemia without symptoms in a dairy herd. They found a definite rise in serum ketones in 70 per cent.

of the herd when kept in stalls in winter. This ketonaemia was not associated with hypoglycaemia. Correlation of blood ketones with the period of lactation or quantity of concentrates allowed for milk production was not close, but was "sufficient to suggest that high-yielding cows were more susceptible, although individuality played the greater role." Similar observations were reported by Holmes (1950b) on the results of regular milk sampling of a dairy herd. This study showed that the cow may excrete appreciable quantities of ketones in the milk and urine without any symptoms of metabolic disturbance being shown. Multiparous cows calving in the period October-February were particularly susceptible. Any interference with food intake, such as sudden change of diet or the introduction of unpalatable food, was particularly liable to result in an increase in the incidence of subclinical ketosis. It is thus evident that many cattle in winter are potential cases of clinical ketosis but the balance is never sufficiently disturbed to result in the development of clinical signs, and in the cow the factor which may be of major importance in maintaining the balance is probably the ability to vary production of milk.

Similarly, in pregnant ewes, Holmes (1952b) observed a tendency for ketonaemia to develop in some ewes but only during the last 8 weeks of pregnancy. There was no accompanying hypoglycaemia and no symptoms were shown, but it is evident that such animals were potential cases of pregnancy toxaemia which would probably rapidly have become clinical cases, particularly if bad weather such as a fall of snow, had interfered with food supplies.

Effects of fasting

Experimentally, pregnancy toxaemia may be reproduced by fasting pregnant ewes in advanced gestation particularly if they are carrying twins or triplets (Roderick, Harshfield & Hawn, 1937; Fraser, Godden, Snook & Thompson, 1938; Holmes, 1952b) whilst undernutrition of the pregnant ewe without withholding all food was found to be effective in reproducing the disease in advanced pregnancy by Hopkirk (1934), Fraser *et al.* (1938), Snook (1939), Clark & Groenewald (1941) and Parry (1950). In the cow, however, typical ketosis has never been experimentally reproduced. Shaw, Saarinen, Hatziolos & Leffel (1949) found that most of the biochemical changes in typical ketosis could be produced by fasting cows in the early post-partal period but symptoms of ketosis were absent. Similar observations were reported by Robertson & Thin (1953).

A typical fasting experiment in a ewe pregnant with twins at 17½ weeks gestation is shown in Fig. 5. All food was withheld for 48 hours and the animal developed symptoms of pregnancy toxaemia 6 days after the end of the fast. The maximum plasma acetone level was 55 mg. per cent.

In the cow, Holmes (1950a) fasted animals in advanced pregnancy and early lactation for up to 96 hours. Due to the rather long post-absorptive period in the ruminant (Dukes (1947) gives a time of 65-80 hours in cattle) the actual fasting period was not as long as would have been the case in a single-stomached animal. The results of 3 experiments carried out on a cow at 183 and 269 days pregnant and 83 days *post-partum* are shown in Figs. 6, 7 and 8. In all the experiments ketonuria developed and in the lactating cow ketones appeared in the milk. Ketonuria appeared in the heavily pregnant animal earlier in the fasting period than in the lactating cow and reached a higher concentration. Only a very mild ketonuria was induced at mid-pregnancy. Acetone was detectable in the breath in both late pregnancy and early lactation. There was no hypoglycaemia and no symptoms developed.

The reason for failure to produce clinical ketosis in the lactating animal is believed to be due to the marked fall in yield which occurred very rapidly after fasting (from 20 lbs. to 5 lbs. per day after 48 hours). Thus the cow was effectively reducing the nutritional

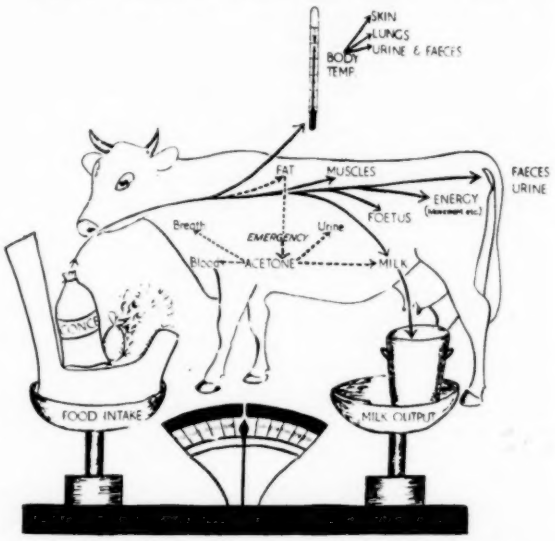


FIG. 4.—The nutritional balance in the lactating cow.

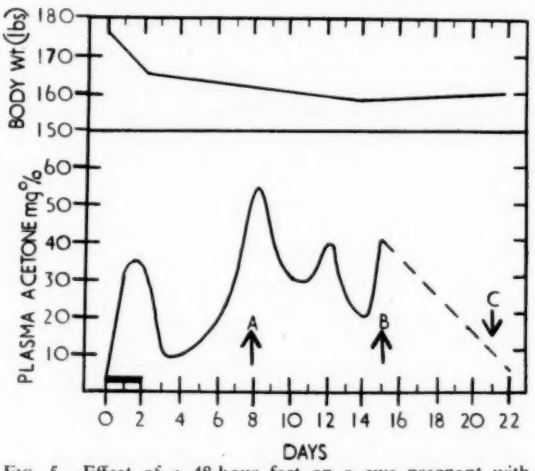


FIG. 5.—Effect of a 48-hour fast on a ewe pregnant with twins at 17½ weeks gestation. At A the ewe developed clinical pregnancy toxaemia. At B the animal began to recover, and at C the ewe lambed twin lambs.

drain, whereas the pregnant ewe was unable to do this and she developed pregnancy toxaemia.

Ruminant Digestion in Relation to Ketosis

The carbohydrate portion of the ingesta is largely converted to lower volatile fatty acids of which approximately 65 per cent. is acetic acid, the remainder being mainly propionic (less than 20 per cent.), and butyric acid (Pfander and Phillipson, 1953). Propionic acid is the only one which may be regarded as a blood glucose or lactose precursor. The acids are absorbed directly from the rumen. The blood glucose level of the adult ruminant is about half that of the single-stomached animal, and it is little affected by feeding. Holmes (1951) demonstrated a negligible rise in the blood sugar after feeding up to 1 lb. per cwt. glucose by stomach tube, and there also resulted a ketonuria presumably due to production of large amounts of potential ketogenic fatty acids by fermentation of the sugar.

The type of food consumed may, by influencing the proportion of these fatty acids, render an animal more susceptible. Thus Adler, Roberts and Dye (1958) observed that silage with a high butyric acid content increased the incidence of ketosis in a dairy herd. In practice silage is such a variable commodity as far as composition is concerned that it is impossible to generalise as to its effects on the incidence of the disease. Certainly high-butyric acid silage would not be good silage!

Disturbances in the composition and vitality of the rumen flora may also play a part in the development of ketosis (Hoflund and Hedstrom, 1948).

In relation to feeding, further investigation might profitably be directed towards determining the influence of different rations on the proportions of the volatile fatty acids produced by bacterial fermentation in the rumen, for a high proportion of propionic acid would appear to be particularly desirable as an antidote to the ketosis syndrome.

Endocrine Factors

It is generally agreed that the ruminant maintains its blood sugar level largely through gluconeogenesis, and this has focused attention on those endocrine glands particularly concerned with this function. These are the anterior pituitary and the adrenals.

Shaw, Saarinen, Hatziolos and Leffel (1949) studied the histological changes in the adrenals and pituitaries of 14 cows with ketosis and observed a similarity between them and those described as a feature of the adaptation syndrome of Selye (1946). Consequently, they suggested that ketosis was due to the effects of stresses additional to the stress of parturition and commencing lactation, resulting in exhaustion of the pituitary and thus a decrease in the production of ACTH with a consequent fall in the output of glucocorticoids by the adrenal cortex.

In sheep Groenewald, Graf, Bekker, Malan and Clark (1941) observed marked fatty changes in the adrenal cortex in cases of pregnancy toxaemia, whereas Holmes (1952b) failed to detect any difference between the adrenal glands of normal and affected ewes. It must be appreciated, however, that in organs with such complex functions as the adrenal cortex, functional abnormality might be accompanied by microscopical changes which could only be recognised by very specialised histological techniques.

Robertson, Lennon, Bailey and Mixner (1957) have suggested that some cases may be due to a relative adrenal cortical insufficiency induced by hypothyroidism, whilst Carlstrom (1950) suggested that the onset of high milk production might result in an increased production of prolactin and a consequent diminution in adrenocorticotropic hormone, but such a theory has never been proven.

In animals and man glucocorticoids can cause lymphopenia and eosinopenia even in the absence of stress (Selye, 1946), and Alexander (1958) found that ACTH in adequate dosage in the normal lactating cow produced an eosinopenia within 2 to 4 hours. The opposite blood findings are not necessarily indicative of deficiency of these hormones. Carlstrom (1950) reported an eosinophilia and an increase in lymphocytes with a reduction in neutrophiles in cases of bovine ketosis, and Shaw (1952) observed that the eosinophiles of cows with ketosis vary from normal to high. Both these workers considered that this may indicate a "pituitary-adrenal deficiency." The writer's observations in uncomplicated bovine ketosis indicate that cases generally appear to fall into two groups—either a normal leucocyte picture, or an eosinophilia often accompanied by a fall in lymphocytes and a slight increase in neutrophiles. It is considered that this is a further illustration of the fact that the disease may have more than one cause. Whilst cows with eosinophilia may be cases of endocrine disturbance, those with a normal blood picture are probably nutritional in origin. It would be interesting to know if there is any correlation between the blood picture and response to treatment with glucocorticoids, and this might explain the apparently variable response of cows with ketosis to adrenal hormone therapy. It might also offer a method of deciding which cows to treat with hormone preparations.

In the ewe, Holmes (1953) reported the leucocyte changes in 8 cases of pregnancy toxaemia. No eosinophilia was observed, in fact there was a tendency to eosinopenia. Apart from one case in which the blood picture was normal, there was a marked rise in neutrophiles and a fall in lymphocytes, but the total white cell count remained constant. Similar observations were reported by Groenewald *et al.* (1941), but they also noted a significant correlation between the percentage of neutrophiles and the blood ketone levels.

Haematological studies therefore suggest that in the ewe most of the cases are nutritional in origin, whilst in the cow the condition may be either a nutritional imbalance or due to reduced gluconeogenesis caused by disturbance particularly involving the pituitary-adrenal cortex hormones.

Symptoms

The principal symptoms of ketosis have been adequately described in both the cow (Fincher, 1936; Freer and Hayden, 1940; Shaw, 1947a; and Sampson, 1947) and the ewe (Dayus and Weighton, 1931; and Hopkirk, 1934). They are those of a digestive or

nervous disturbance. In cattle the nervous form is less common than the digestive, but in the ewe involvement of both systems often occurs together. Particularly in the cow, many workers distinguish primary and secondary ketosis. This in the opinion of the writer is unfortunate, for in so-called secondary ketosis the ketosis (which is often only ketonuria and very mild ketonaemia) is only a symptom of some other disease, the diagnosis and successful treatment of which will generally result in a resolution of the accompanying ketosis. The term ketosis should be reserved for the metabolic entity alone, caused by nutritional or endocrine disturbance, and in all cases of ketosis in cattle the possibility of some other underlying disease causing the accumulation of ketone bodies should be eliminated before the diagnosis is confirmed.

It is of interest to speculate as to the possible cause of the symptoms. In the cow several suggestions have been put forward including "liver dysfunction," which might include interference with detoxication mechanisms due to extreme fatty infiltration (Sjollema, 1932; Hayden, 1940) or inability to maintain the normal blood sugar level (Roepke, 1942). That the symptoms are not due to a low blood sugar level is indicated by the work of Reid (1950 a and b), who showed by administration of insulin to sheep that 5 mg. per cent. blood sugar was the critical level at which signs of hypoglycaemia appeared. In ketosis blood sugar is invariably higher than this and in many clinical cases the blood sugar level is in the normal range. That the symptoms are not due to ketonaemia *per se* was shown by Holmes (1950a), who administered acetone by mouth to normal cattle in doses varying from 0.18 to 1.4 ml. per kg. The latter dose appeared to be rather toxic, in that the pulse rate was temporarily elevated and there was gritting of the teeth and depression for about 12 hours after dosing, but appetite and rumination were not affected. The effects of administration of acetone on blood sugar and serum and milk ketone levels are shown in Figs. 9, 10 and 11.

Sheep provide the best opportunity to correlate symptoms with lesions, for in this species mortality is high. Some fatty infiltration in the liver is a normal feature of pregnancy in most animals. Hence it is necessary to exercise care in ascribing any significance to this feature. In severe cases of pregnancy toxaemia extensive swelling of hepatic cells is a notable feature, so much so that in many cases the normal columnar arrangement of liver cells cannot be recognised (Fig. 12). Whilst species analogy may be dangerous it is worth noting the observations of Himsworth (1950) writing on the subject of hepatic pain in man. He stated "when the liver enlarges rapidly, then the patient becomes conscious of discomfort in the upper abdomen . . . in the most severe the pain may be so intense as to suggest an acute abdominal emergency. The severity of the distension pain is proportional to the speed of hepatic enlargement." It is highly likely that the factor which determines the onset of symptoms in the ewe is not the degree of fatty infiltration but the speed with which it occurs. This idea is in line with the observation of Phillipson (1950) that the effect of

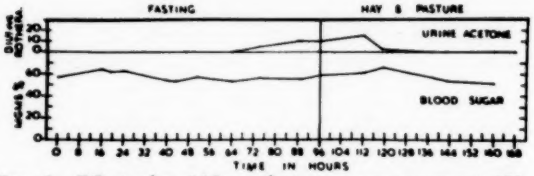


FIG. 6.—Effect of a 96-hour fast on a cow pregnant 183 days.

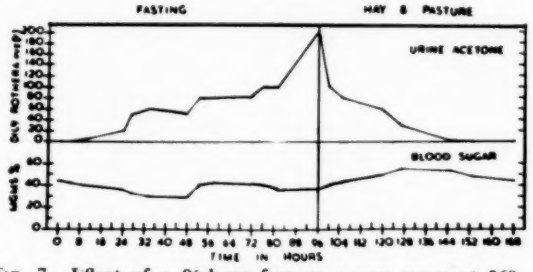


FIG. 7.—Effect of a 96-hour fast on a cow pregnant 269 days.

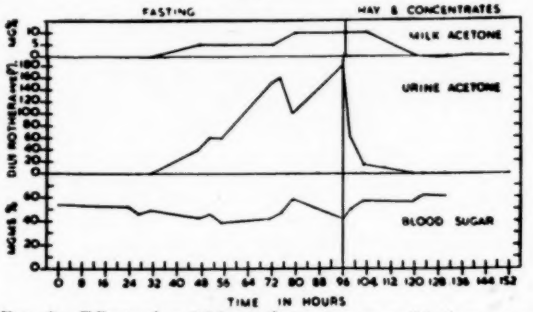


FIG. 8.—Effect of a 96-hour fast on a cow 83 days *post partum*.

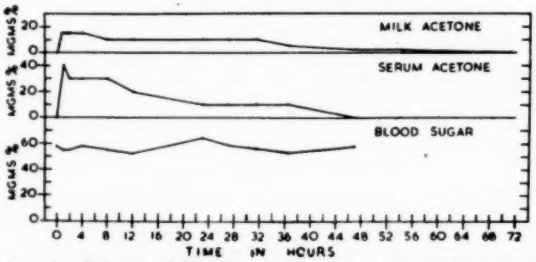


FIG. 9.—Effect of 0.18 ml. acetone per kg. b.w. administered by mouth to a heifer 189 days *post partum*. Not pregnant.

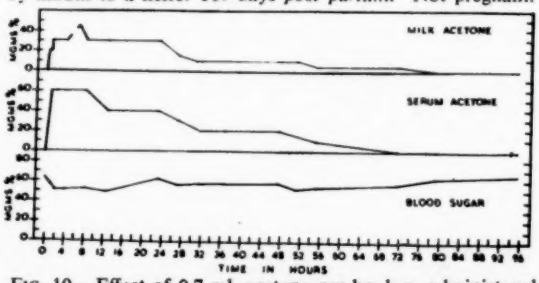
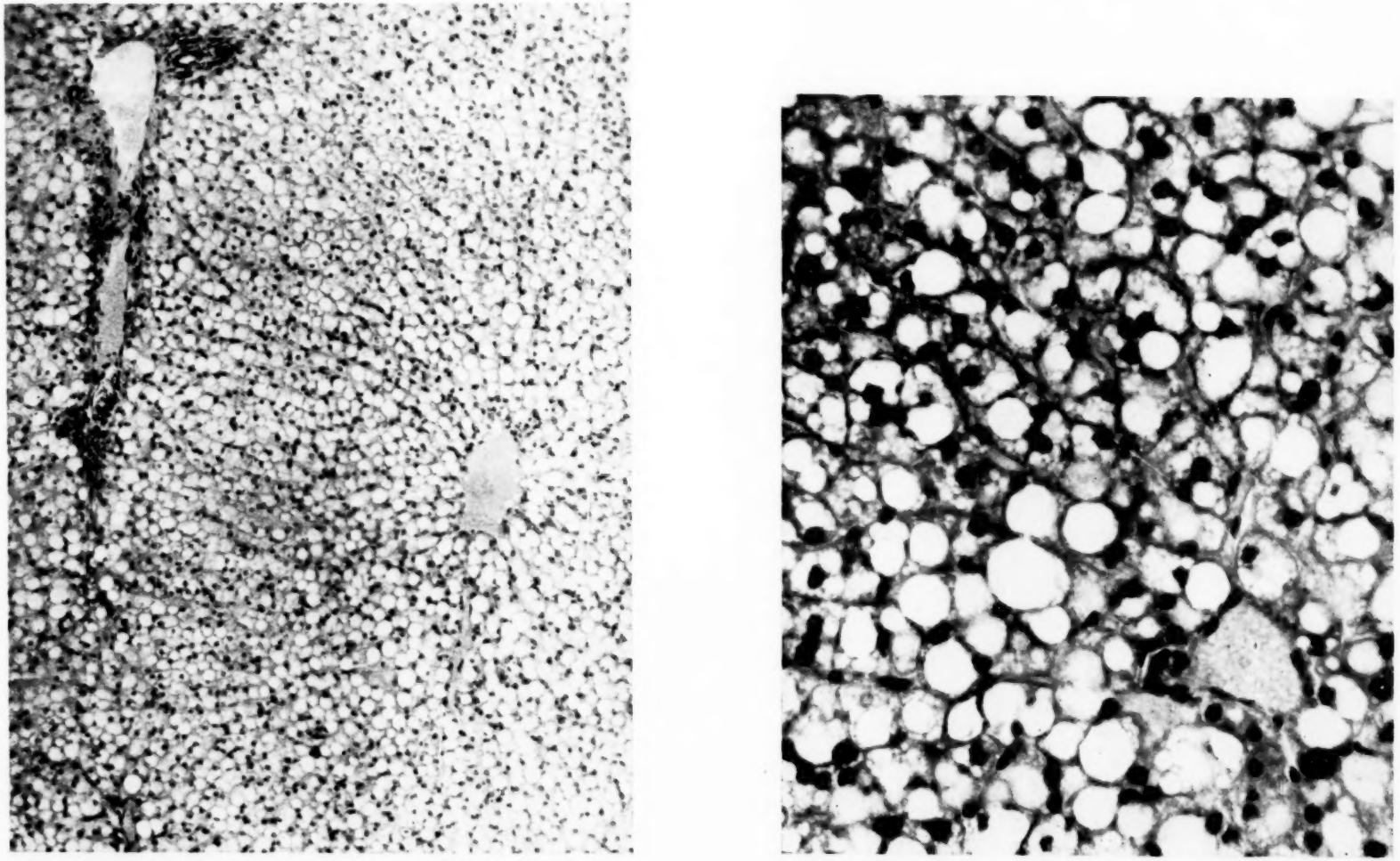


FIG. 10.—Effect of 0.7 ml. acetone per kg. b.w. administered by mouth to a heifer 200 days *post partum*. Not pregnant.



(a) (b)

FIG. 12.—Section of liver from ewe, with pregnancy toxaemia. Destroyed for *post mortem* after 11 days' illness. Pregnant with twins.

(a) x 112. (b) x 540 in region of central vein.

Note the marked fatty infiltration and the swelling of liver cells filled with fat.

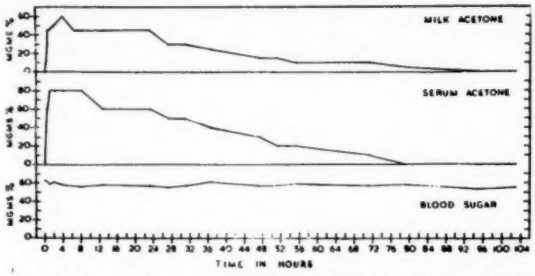


FIG. 11.—Effect of 1.4 ml. acetone per kg. b.w. administered by mouth to a heifer 207 days *post partum*.

fasting pregnant ewes was not so marked in ewes previously on poor rations because they were already attuned to the use of body fat. The symptoms shown by typical cases of pregnancy toxaemia are suggestive of an animal with abdominal pain—the pressing of the head into obstacles, the placing of the forefeet in water and the gritting of the teeth. It was observed that ewes showing the most acute symptoms, with inability to stand and often blindness, show livers with the most advanced and extensive fatty infiltration (Holmes, 1952b).

Another possible explanation in the ewe may be mechanical interference with the alimentary tract resulting in digestive disturbances which could initiate the syndrome, for one is often impressed by the great volume in the abdominal cavity occupied by a uterus containing two or three foetuses, their membranes and fluids.

Diagnosis

The history of advanced pregnancy in the ewe or early lactation in the cow is an important guide plus the presence of typical symptoms. Confirmation depends on the demonstration of ketonaemia. Ketone bodies being volatile substances are excreted in the breath and milk and may be detected by their characteristic sickly-sweet smell. Kidneys concentrate ketone bodies and a ketonuria may be present without a significant ketonaemia. Thus urine testing is completely valueless as a diagnostic aid in the ruminant.

In cattle a rapid and reliable field test may be applied to the milk. This test, based on the very sensitive Rothera's Test has been described by Paterson (1945) and is semiquantitative. From the results an estimate of the blood value may be obtained, serum acetone being approximately twice the milk value. Blood may, of course, be sampled for ketones and for sugar, but a hypoglycaemia is not an invariable finding and there is no correlation between the degree of ketonaemia and the degree of hypoglycaemia.

In the pregnant ewe the breath is a good guide and blood may be sampled for ketones. At *post mortem* the characteristic changes are multiple foetuses *in utero* and extensive fatty infiltration in the liver which may be ochre-yellow in colour. Whilst death of the lambs may occasionally precede that of the ewe, there is no evidence that foetal death is a primary aetiological factor. If death of the lambs occurs *in utero*, ketone bodies disappear from the breath and blood generally within 24 to 48 hours. The animal then makes a biochemical recovery but there is no clinical improvement. If putrefication occurs there is often a terminal uraemia. Occasionally, whilst one or two lambs may die *in utero*, one survives and may be carried to full term. Putrefaction does not occur in this case, the dead lambs becoming mummified. The ewe may then make both a biochemical and a clinical recovery. Thus typical cases of pregnancy toxaemia with ketonaemia may recover spontaneously, but if ketone bodies disappear and the animal does not improve clinically, it is highly likely that there are dead lambs in the uterus.

Differential diagnosis:

In the ewe the following conditions may be confused with pregnancy toxaemia in the field:

1. Lambing sickness (hypocalcaemia). Pregnancy toxaemia only affects pregnant ewes. Hypocalcaemia may be encountered both during pregnancy and lactation. Where there is any uncertainty intravenous test therapy with calcium should be tried. Hypomagnesaemia is also now being recognised in sheep particularly when put on improved swards (Penny & Arnold, 1955; Pook, 1955) or following change of environment. Again test therapy will help to differentiate.

2. Acute fascioliasis. Occasionally in flocks lambing very early in the season, the dullness associated with traumatic hepatitis may resemble the symptoms of pregnancy toxaemia.

3. A case of dystokia may be mistaken by an owner for one of pregnancy toxaemia. It is considered advisable, particularly in ewes showing symptoms in which no acetone can be detected in the breath, to examine *per vaginam*, as the case may be one of prolonged dystokia, in which no parts of the foetus are protruding through the vulva.

4. Coenuriasis—occasionally the sporadic case, if it occurs in a pregnant ewe, may be confused.

In the cow in the period 1 to 6 weeks *post-partum* several digestive or nervous conditions must be differentiated and some of them may show mild ketosis as one symptom if milk yield is maintained. The conditions include:

1. Displacement of the abomasum. This condition, mentioned by Begg (1950) and subsequently described by numerous workers, may be confused with ketosis. Whilst not wishing to exaggerate its incidence it would seem advisable in any case of ketosis which does not show clinical improvement within 14 days to consider the possibility of abomasal displacement as a definite complication.

2. Traumatic reticulitis. The reticulitis syndrome is very variable in its clinical manifestations but a typical initial penetration is generally associated with an abrupt fall in milk yield. In ketosis the fall in yield is usually more gradual.

3. Early cases of Johne's disease associated with progressive wasting.

4. Pyelonephritis occasionally must be differentiated.

In the nervous form the following must be considered in differential diagnosis:

1. Hypomagnesaemia.

2. Lead poisoning.
3. Listerellosis.

Preventive Measures

Although much remains to be discovered regarding the complex chemistry of this metabolic syndrome, and the condition may be induced by more than one aetiological agent, certain recommendations regarding prevention may be made in the present state of knowledge.

Prevention of pregnancy toxaemia

In order that lambs shall be born in the spring at a time when natural food supplies are reasonably good to stimulate milk secretion in the ewe and later provide a good bite for the young lamb as it starts to graze, Nature requires a ewe to carry her lambs at a time when natural food supplies are progressively diminishing. During the months of late December, January and February particularly, the nutritional value of herbage is poor.

Observations on the feeding of 29 flocks, from which cases of pregnancy toxaemia had occurred (Holmes, 1953), showed that in only 2 of these flocks was concentrate feeding practised. Whilst the supplementing of grass with roots, kale and hay may be of benefit, it is considered that the use of concentrates is of particular value in preventing this disease. Ewes in advanced pregnancy, particularly if pregnant with twins or triplets, require a production ration. Important points to remember regarding the feeding routine in lowland flocks are:

1. At tupping provide a good sward to flush the ewes, then
2. Put on poorer pasture in the early part of pregnancy (2 to 3 months). This is important to prevent the ewes getting too fat and also to permit the nutritional plane to be raised later in pregnancy.
3. Commence concentrate feeding at about 110 days of pregnancy (4 months). Cases of pregnancy toxaemia generally appear from about 120 days onwards.

In concentrate feeding:

(a) Start with a small quantity, say, ¼ lb. per head per day, and gradually increase.
(b) Once concentrate feeding has been started it must be maintained daily until lambing. The maintenance of the nutritional balance depends on a regular intake of food and only one day's omission may be equivalent, under natural conditions, to the effects of a snowfall which, although it may only last for 24-48 hours, is often sufficient to induce a negative nutritive balance and cause the development of the disease.
(c) Provide adequate trough space.
(d) In large flocks separate out the very heavily pregnant ewes, cases of foot-rot or broken mouthed ewes, and feed them separately. These are most susceptible and are less able to compete with the more robust sheep for trough food.
(e) Attend to all cases of lameness in a flock as they are particularly vulnerable to unfavourable environmental conditions.

There are flock owners who are sometimes loath to feed their ewes because they believe they are "too fat" and that this results in a high incidence of maternal dystokia at parturition. It is very much to be doubted whether this assumption is correct. It is much more likely that in the majority of flocks the animals are gaining in bulk rather than weight, and increasing fleece growth may also give an erroneous impression of excessive fatness. Even if the animal is fat, this would seem of little value in preventing pregnancy toxaemia, for it is when the animal starts to utilise the fat that excessive ketones accumulate.

In hill flocks the incidence of pregnancy toxaemia is low because twinning is less, but ketosis may develop when heavy falls of snow interfere with nutrition. Hill flocks may present a problem in regard to the feeding of concentrates, for many hill sheep, untrained to trough feed as lambs, would starve to death rather than eat them. Furthermore, on hill farms where hardiness of the sheep stock is of prime importance, it might be undesirable to feed supplements. In the majority of seasons late lambing and no flushing at tupping time will minimise the incidence of this disease and it becomes serious only when weather conditions (which are unpredictable) induce a starvation syndrome.

Exercise has been reported by many observers to be of value in prevention (Gilruth, 1924; Greig, 1929; Dayus & Weighton, 1931; Cameron & Goss, 1940). It may be of value by unlocking stores of muscle glycogen and rendering them available as a source of assimilable carbohydrate, and Dye & McCandless (1948) observed that in the normal animal exercise increases the utilisation of ketone bodies about 10 times. Observations by Holmes (1953), however, indicated that provided animals are receiving a generous food allowance, lack of exercise is of no importance in the development of the disease. Exercising the flock may be of value in the early detection of cases, for one of the first symptoms shown by affected animals is that they lag behind when the flock is driven for any distance.

Prevention of bovine ketosis

Selection for high production without accompanying selection for freedom from metabolic disease may be the root cause of many of our troubles. However, certain recommendations may be made in an attempt to reduce the incidence of this disease. These include:—

1. Maintain a balanced food intake: milk output by feeding according to yield, including some roughage to prevent digestive upsets, particularly in the early part of lactation in cows calving during winter or early spring.
2. Make all food changes gradually, particularly after calving, and avoid the introduction of unpalatable food, for failure to eat for only one day may be sufficient to upset the balance.
3. Where a herd problem exists it may be a good plan to divide the concentrate ration over 3 or 4 feeds per day instead of the usual 2. This may aid digestion, particularly in high yielders requiring a fairly large concentrate ration, and thus prevent

the digestive upsets which may initiate the ketosis syndrome.

4. The use of kale, cabbage and roots may help to encourage appetite in the post-parturient period in cows kept in stalls.
5. The disease is sometimes seen in cattle during the summer but the majority of cases occur in winter. When a cow appears susceptible to the disease it may be necessary to arrange for it to calve in the summer months on grass.
6. An early bite of grass in spring is beneficial in reducing the incidence in a herd.
7. It is possible that occasionally low external temperature may predispose particularly in a cow in which food intake : milk output is very finely balanced. Dodd (1957) observed that unless the environmental temperature reaches very low levels (below 10° F.) milk yield is not seriously reduced. This fact, combined with the increased energy requirements for the maintenance of body temperature may thus upset the nutritional balance.

The composition of the concentrate ration

Concentrate feeding is considered to be of particular value in the prevention of ketosis in the ruminant. What constituents of the "concentrates" are of importance? To answer this question more investigation is necessary. The carbohydrate components of the ration might be considered to be of particular value as the ketosis syndrome develops in association with a depletion of hepatic glycogen and a reduction in blood sugar, but the important part played by protein in the growth of the foetuses *in utero* and in milk production should not be underestimated. Until further work is done on the preventive role of carbohydrate and protein it would seem reasonable to advise the use in both sheep and cattle of a good production ration balanced for both these constituents.

Treatment

In the cow, mortality is low even if no treatment is applied, the animal tending to recover spontaneously, probably largely owing to a fall in yield. This does not mean that treatment is of no benefit, for therapeutic procedures that will reduce the period of morbidity have an important value. Many drugs, however, have gained a reputation as therapeutic agents in which credit should have been ascribed to *vis medicatrix naturae*. Consequently a very wide range of drugs have been described as being effective in treatment.

In the ewe, mortality is high. The best that most drugs do is to maintain the animal until parturition, for this is the factor generally associated with commencing recovery. Thus pregnancy toxaemia provides a better means of assessing the therapeutic value of drugs in the treatment of ruminant ketosis.

Briefly, present methods of treatment may be divided into 4 groups:

1. Correction of the hypoglycaemia and an attempt to raise the carbohydrate reserves with substances such as glucose intravenously or subcutaneously, or glucose precursors by mouth such as sodium propionate (Schultz, 1952), glycerol, propylene glycol (Johnson, 1954) and ammonium lactate (Seekles, 1951). Cessation of milking, with presumably a similar effect, was mentioned by White (1952).
2. The use of hormones, particularly ACTH and glucocorticoids—cortisone and its many derivatives. These were first used in the United States by Shaw (1947b) and were recently evaluated in Great Britain by Paterson (1957).
3. The use of substances essential for the intermediate metabolism of carbohydrate. Thus experimentally Reber & Schoettle (1955) used sodium ethyl oxalacetate and Ho & Reber (1957) described the effects of oxalacetic acid on hypoglycaemia and ketonaemia in fasted pregnant ewes. The results were not spectacular. This field of investigation is fairly new and further studies along these lines are necessary before it will be possible to assess the value of these and similar substances in the therapy of field cases.
4. Miscellaneous drugs such as chloral hydrate and sodium bicarbonate are widely used, alone or combined with carbohydrate therapy.

Conclusions

These diseases may be regarded largely as man-made diseases of cattle and sheep in that they result from increased production demands. High agricultural production must be maintained and improved and production and health are interdependent. Robertson (1954) stated "in our sphere of work health means little if divorced from production."

The agronomists have made two blades of grass grow where one grew before, but this has been accomplished not only by attention to the fertiliser treatment of the soil but also by the selection of strains of grasses capable of responding and existing in the somewhat artificial environment. The same rules apply to our herds of cattle and flocks of sheep. Increased production may be obtained by efficient methods of animal husbandry including attention to the food supply of the animal particularly during the periods when production demands are greatest (and we still have much to learn in this respect). Whilst there is no definite evidence at present that these diseases are heritable, any genetic tendency may be masked by the fact that many present-day cases are probably due to errors in management. We must first be reasonably sure that methods of management are satisfactory and then select and breed from those animals which metabolically are capable not only of high production but also of existing in the artificial environment free from metabolic upsets. I suggest that little so far has been done in this respect. Too much importance is laid on production figures with little regard for the ability of the animal to remain free from metabolic disease. Today, the farmer can get plenty of advice regarding feeding and management in relation to production. The veterinary profession must provide him with advice regarding the relationship between feeding, management and disease prevention.

It is, of course, true, that ideas will change or be modified with time and the results of further investigations, and that recommendations which seem reasonable now may need modification later. That does not mean, however, that we must wait until all the problems are solved before giving advice in these matters. There is a tendency for the metabolic disorders to be regarded as so complex and imperfectly understood that little can be done about them at present. Whilst I agree they are complex and much more work is required for their solution, I believe that useful recommendations may be made regarding prophylactic measures, and in this respect ketosis in the ruminant is one which might well be reduced in incidence by education of the farming community, particularly concerning feeding, management and breeding. I consider that attention to these details will result in a reduction in the incidence of this disease in cattle and sheep.

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THE SPEAKERS' INTRODUCTION

Mr. L. E. Hughes said he thought it would be generally agreed that there was an increased incidence of the diseases in which they were interested that afternoon, and there could be no doubt that there had been an increase in agricultural production generally. The span of life of the dairy cow had been lengthened and, consequently, relatively old animals had been called upon to increase their production; it was suggested that there might be some correlation between these two factors. The length of the grazing season had been increased and this had been done at both ends. This meant that at certain periods of the year animals were being given food which was potentially low in certain minerals such as calcium and magnesium. Many of the best farmers obtained their silage and hay early when the calcium and magnesium content might be low. A diet of this type was conserved and fed during the winter and when the animals receiving it were turned out on to early grass, which might or might not have received nitrogen, they would again be offered material potentially short of calcium and magnesium at a time of the year when their needs were greatest.

In connexion with pregnancy toxaemia, it was essential for farmers and others to realise that the ewe must gain weight. It was not merely a question of maintaining weight. If weight was only maintained, the maintenance was largely concerned with the growth of the foetus and the ewe was in in fact losing weight.

Hypocalcaemia and hypomagnesaemia in sheep were seasonal, in winter there was a fall in blood levels of calcium and magnesium. As far as hill sheep were concerned clinical cases were found to occur after the ewes were moved from the hills and frequently the trouble came quickly after a period of stress such as a long walk from hill to lowland grazings. A similar phenomenon occurred with lowland sheep which were subjected to a very sharp change in diet, and many cases of hypomagnesaemia occurred in animals which were turned on to a green cereal crop, *e.g.* wheat, oats, or rye.

The term "metabolic disease" was used in relation to diseases in which a biochemical factor was concerned but there the cause of the disease was still obscure. If that formula were applied, other conditions might have been included and the speaker suggested that hypocupraemia might be brought up during the course of the discussion.

So far as further work was concerned, it was felt that one of the functions of the veterinary schools was to deal with applied physiology and that research on diseases of this type could be carried out in an animal husbandry department linked with a department of physiology. Some of the work in the field of nutrition would have been done better in the veterinary schools.

Mr. Hughes said that if there was any merit in what he had said it was the result of his discussions with veterinary and non-veterinary friends and with farmers whom it had been his privilege to serve.

Mr. C. Weighton, in presenting his paper on "Vitamin D in Milk Fever in Cattle," said that the subject of the paper was of interest to all veterinary surgeons, particularly those engaged in farm practice. The literature on milk fever was quite extensive; consequently, he would not take up time discussing the history of the disease, but would confine his remarks to the prevention of milk fever by feeding massive doses of vitamin D to susceptible cows.

Although that procedure might be shown to be very effective, some success was obtained by other methods. Two of them were of especial importance. The first consisted of the intramuscular injection of dihydrotachysterol 2 days before calving; the second of the feeding of a low-calcium high-phosphorus diet during the last month of gestation.

In the United States Drs. Hibbs and Pounden had pursued extensive trials with viamin D for a number of years. Their first trials consisted of feeding small doses of vitamin D for 2 to 4 weeks *pre-partum*. By that method, however, there was tendency for the animal to maintain a normal calcium level, so that the cow's own parathyroid glands were not needed and as a result lapsed into a hypoactive state. In their later trials large doses were fed night and morning for 5 to 7 days *pre-partum*, with much more satisfactory results.

The 8 cases described in the paper received not fewer than 15,000,000 units night and morning. All the cows had had an attack of milk fever at the previous parturitions and only one failed to respond to the prophylactic effect of vitamin D. That cow was affected the previous autumn and had a relapse within 36 hours. Of 8 cases, 3 calved at 6 days and the others at 2, 8½, 10½, 11, and 17 days after the commencement of the feeding of vitamin D, the average period being 8 days.

A short account of each case as it came within the trial would help the meeting to assess the value of vitamin D. The chemical data on calcium were given special consideration since the acetone levels were normal and the magnesium and phosphate values showed only slight alterations.

Case No. 1 received vitamin D for 8½ days and calved 24 hours after receiving the last dose. The serum calcium level remained above 10 mg. per cent. throughout; the second cow received vitamin for 53 hours before calving, but the whole amount was eventually fed. Even the feeding of vitamin for such a short period *pre-partum* appeared to be effective and that was borne out by the calcium level, which remained above 8.

The third animal had vitamin D for 6 days and calved within 24 hours of the last dose being given. The calcium level remained above 9 mg. per cent. serum. The fourth case proved more interesting as the cow had an attack of milk fever 5 days after consuming the final dose of vitamin. The calcium level was 5.3. At the previous attack it was 3.1. It might be thought that the vitamin had ceased to have a calcaemic effect by the fifth day after calving. If that were so it did not explain why case No. 7, which was without vitamin for 8 days *pre-partum*, made satisfactory progress. Probably there was a relationship between the attack and the relapse of the previous year.

Case No. 5 called for no special comment. Vitamin D was fed for 6 days *pre-partum* and the second blood sample showed a serum calcium level of 11.5. The result proved satisfactory in the sixth cow, although the final calcium level came within the milk fever range.

The seventh case was given two additional doses of vitamin D, one on the eighth day and one on the ninth day. The cow was without vitamin for 8 days, which was 3 days longer than the one that had an attack (case No. 4). The cow made good progress, although the calcium level dropped within the milk fever range.

Case No. 8 also received an additional 30,000,000 units, but the vitamin was distributed over a period of 11 days up to the date of calving. The average serum calcium level of the last two samples was 8.6.

Since those cases were recorded, 4 more had come within the trial. One had had an attack of milk fever.

Mr. Weighton then showed two graphs of the chemical data, both indicating the favourable calcaemic effect of vitamin D. The first graph showed the data from the vitamin D group and data from normal cows at calving. The calcium level in the group of normal cows was 8 mg. per cent. serum at the time of calving; and in the vitamin D group it was 8.6 12 hours after calving, and at the same level 31 hours later. The blood inorganic P. was 4 mg. per cent. in the normal group at calving and 4.7 in the vitamin D group 12 hours after calving. The magnesium levels were about normal.

In the second graph the chemical data were from bloods taken 11 hours after calving from the vitamin D group and from bloods taken 7 hours after calving from another group of cows that had milk fever at the previous parturitions. The calcium level in the vitamin D group was 8.6 and in the other group 7.5. The blood inorganic P. was 4.7 in the vitamin D group, and 3.1 in the other group. The serum magnesium levels remained about normal in the vitamin D group and showed a slight rise in the normal group. Those figures might not supply convincing proof, but the final results of the trial indicated that they had in vitamin D a valuable agent for the prevention of milk fever in the cow. Having emphasised the most important points in the paper, he hoped that a good discussion would follow.

Dr. J. R. Holmes, in presenting his paper on "Ketosis in the Ruminant," said that the subject was last considered at a Congress in Cardiff in 1950. In a review of the past 8 years it might be said that little information had been added regarding the fundamental aetiology of the disease, in fact, it would be easier to write a paper on the problems requiring solution than on those already solved. The whole subject was bristling with question marks. Quite a number of new drugs had, however, been introduced, particularly endocrine preparations and glycogen-sparing substances such as glycerine and sodium propionate.

Ketosis was largely a man-made disease of cattle and sheep, associated with intensive methods of production. Whether the health and well-being of the animal was affected adversely as a result of the increase in production depended upon the metabolism of the individual animal within its environment. Individuality was of great importance in relation to the incidence of the metabolic diseases. Increased production had presented problems, but they must not attempt to avoid those problems by accepting a lower level of productivity. It was essential that agricultural production should be maintained at the present level and even improved; but if that was to be accomplished, the producing animals must be capable of existing within the artificial environment free from metabolic diseases. The more artificial the environment became, the more attention to details of animal husbandry was required if animals were to thrive and respond to the maximum. They saw that particularly in the artificial rearing of baby pigs, where any errors of management might result in disaster.

The paper might be divided into 4 main parts: (1) observations in relation to aetiology; (2) correlation of symptoms with lesions; (3) diagnosis; and (4) preventive measures. As to the first part, he had tried to divide the fundamental causative factors into two groups: nutritional and endocrine. The influence of nutrition as a factor in the aetiology might depend upon a balance between food intake and production demands. In the cow the drain on food reserves was due to the onset of milk production and in the ewe to the presence of multiple foetuses *in utero* in advanced gestation.

Imbalance in both species resulted in ketonuria and ketonaemia with depletion of carbohydrate reserves and infiltration of fat into the liver. The importance of nutrition in the aetiology was further emphasised by the fact that a fall in bodyweight was a prodromal symptom of

pregnancy toxaemia in the ewe and ketonaemia could be induced by a short period of fasting in late pregnancy.

The recognition of subclinical ketosis (ketonaemia without symptoms) in the cow in early lactation and the ewe in advanced pregnancy indicated that there were many potential cases which never developed clinical signs probably because the nutritional balance was restored either by reduction in production demands or by improvement in the nutritional status.

The high incidence of ketosis in the ruminant as compared with other herbivores suggested a predisposition which might well be related to the presence of the rumen at the anterior end of the digestive tract. All ingesta was first subjected to bacterial fermentation and some of the resulting products were ketogenic.

As to the second part of the paper, the correlation of symptoms with lesions, that could best be studied in the ewe because, the mortality being high, there was more opportunity for *post-mortem* examination. Some fatty infiltration in the liver was a normal feature of pregnancy in all species and it was a characteristic finding in pregnancy toxaemia in the ewe. Those ewes showing the most severe symptoms (blindness or inability to stand) had livers with the most advanced and extensive fatty changes associated with marked swelling of hepatic cells. Cases of pregnancy toxaemia occurred in which the extent of fatty change in the liver was not dissimilar from that in normal ewes pregnant with twins or triplets. It was probably the rate of fatty infiltration which was important rather than the extent, and some of the symptoms shown might be due to liver distension pain.

As to treatment and prevention, he had purposely said little about treatment for he had had little opportunity to evaluate the various drugs available. While not wishing to minimise the value of therapy, he wanted to emphasise the importance of preventive medicine in the disease. It was considered that concentrate feeding was of particular value in prevention of pregnancy toxaemia.

No preventive measures could be guaranteed to be 100 per cent. effective, even in diseases in which the exact aetiological agent was known. Much less could be expected when dealing with a syndrome in which the aetiology was so complex and where more than one agent might produce an identical clinical picture. However, useful recommendations might be made and the appearance of cases in a herd or flock should lead one to consider not only the treatment of the individual animal but also prophylactic measures. Initially that would be largely advice regarding nutrition in relation to food requirements and production.

It was from attention to detail that success would result: it was not just a question of feeding concentrates, but of When?, How much?, How?, etc. Genetic factors might be concerned, but he had no supporting evidence. The problem was complicated by the fact that many cases were nutritional or endocrine. Where sound methods of management were practised an opportunity might arise to select animals capable of high production which remained free from metabolic disease. That must be their ultimate goal. There was therefore the immediate and short-term problem of reducing the incidence of metabolic disorders and the long-term problem of building up herds and flocks free from these metabolic upsets.

Dr. Holmes believed that if advice regarding prevention was adequately disseminated amongst the farming community and properly applied by the farmers themselves—veterinarians could only advise, they could not make farmers carry out their advice—there would be an appreciable reduction in the incidence of these diseases without a reduction of the standards of production; in fact, it might well permit an increase in productivity.

The Openers

Mr. D. T. Michael, in opening the discussion, said they were dealing with a cycle of interrelated events forming a pattern in which it was not always so easy to perceive or assess what might be at fault—a pattern modified still further by the nature of a particular farming programme, tempered by day-to-day management and distorted by seasonal variation. The successful interpretation of an unfamiliar pattern rested upon the omission of irrelevant detail, and so in the field one of the greatest problems was learning to do that, unless the investigator was to finish with a mass of unco-ordinated data.

Hughes's opening theme drew attention to the complexity of body processes; he then went on to outline the generalities, leaving space for addition from the general discussion. Holmes stressed the balance and in a masterly presentation of the subject drew attention to genetic factors. Both papers were timely reminders that, apart from active and passive induced phases of acquired immunity, there existed environmental, inherited genetic, and herd habit factors for consideration within the broader field of immunity.

He had been asked to restrict his remarks to husbandry, but must first confess to being unable to correlate clinical findings with biochemical determinations, or to determine the dividing line between metabolic disorders and enterotoxaemias, despite the fact that he recorded that association 12 years previously.

Basic concepts of animal existence had been stipulated as the search for food, attempted preservation, and reproduction. Preservation required shelter, among other things, particularly so since the dynamic background of some of the disorders appeared associated with the extension of the grazing season, obtained by encroachment upon the less clement periods of the year, late winter or very early spring. Shelter was one serious omission. The hazard lack of static shelter assumed even greater importance with reduction of the grazing area, particularly at higher elevations. Mobile shelter was provided by hair or fleece. How often was that overlooked by the proud owners of sleek-coated cows that were turned out early in the year.

A controlled field experiment undertaken during the spring of 1950 produced a fourfold increase in the incidence of milk fever or lambing sickness associated with lack of shelter, during a storm period of 4 days' duration. The cases numbered 10 and 37 respectively. It was unfortunate, too, that experiments connected with the grazing animal, when undertaken in loose-boxes or buildings, ruled out the possible influence of exposure. The influence of shelter upon early growth required no further comment. A further point concerning shelter was its influence on grazing behaviour. With shelter there was sustained foraging; without shelter there were restricted periods of grazing with inadequate rumen fill. Perhaps nearly two decades of near monastic seclusion on the higher altitudes had assisted in an appreciation of this fact.

The greater part of the disorders fell within the period of near cessation of pasture growth and its resurgence the following spring; it was an increasingly critical period with the higher rates of stocking. During that period a temporary readjustment could be made by removal to other areas, or the position might be met by supplementary feeding, by hand or with crops conserved for the purpose.

Milk production within this period would be obtained from home-produced food or purchased concentrate, or both. The ill effects of too narrow a nutrient ratio and inadequate fibre had been pointed out. Disorder sometimes limited the quantity of home-grown food that could be consumed and required the further addition of purchased concentrate. Was shortage of protein of higher biological value a limiting factor in such cases? What of mineral supplements, particularly salt? What of a short period for adjustment after calving before pushing on with production? Now, with the emphasis on economy of production, what were the views concerning the practice of not feeding in anticipation of production, but limiting the ration irrespective of production, where the potentially higher yielders were expected to rough it along with others?

Within this period of restricted growth sheep were included and to many stock-owners this was an unfamiliar animal. The problem of providing a future generation of good shepherds was indeed serious. Before setting forth recommendations on husbandry it was as well to see the problem in its true context, which was to carry on ewes to lamb down, fit with a sufficient supply of milk, a good maternal instinct, and viable lambs. That alone was sufficient to recommend a balanced diet rather than any insistence on carbohydrate-rich supplements such as had been made in the past.

Many problems arose with and from supplementing the diet of hill sheep, but that was quite successfully undertaken. The feeding of hill sheep was a subject in itself and one that could be over-simplified. The fundamentals were those of maintaining foraging instinct, regulating supplies so that dams were not conditioned to a high plane of nutrition and then returned to the hill to face comparative starvation, the splitting up of numbers so as to avoid large concentrations, together with other points that Hughes had brought up. It was one of the most intricate problems and it took years of study to learn the snags.

There were one or two points to be raised concerning movement. Voluntary movement or foraging instinct in some sheep became depressed with advancing pregnancy. It was more prevalent in anaemic, under-nourished ewes and those in gross bodily condition. Whilst sufficient emphasis was placed upon the extra demands of multiple as opposed to single pregnancy, another aspect was overlooked and that was fatigue and the increasing periods of resting incurred with the heavier loads of pregnancy; consequently, the foraging period was reduced and so was the tummy capacity, at least within the zone of comfort. Therefore, on a sparse but palatable sward some ewes were unable to eat sufficient food compared with others less heavily handicapped with a foetal load and therefore capable of longer periods of foraging. So the differences in condition which might be observed between ewes carrying singles and others with twins should not all be ascribed to extra foetal demands.

However informative weight gains might be, routine weighing of a moderately large flock was regarded as impractical and generally left until action time. Holmes had indicated that weight gain during pregnancy might still be associated with loss of condition. The weakest links in the chain were those animals losing condition too rapidly; head carriage, general alertness, gait, wool tear, and a hollow flank helped in sorting them out for preferential treatment.

It was possible that the rôle of exercise was compensatory. There appeared to be many possibilities. There was respiratory exchange and P.H. increasing negative intralhorocic pressure, thereby assisting circulation. The main flow to the liver and from the liver was venous. The hepatic artery had little to do with the portal circulation. Again, the movement assisted peristalsis. Dietary sufficiency or intake was one stage; digestion and absorption another before proceeding with utilisation, retention, and excretion.

The type of movement precipitating disorder *per se* was essentially bad management and arose from impaired judgment. The season 1956-7, however, was in some respects remarkable; nature, in extending the grazing season, had outdone the agronomist.

The question of abrupt changes in diet occurring during the onset of spring growth could not be minimised. Earlier controlled field trials employing some 500 ewes per season had shown this quite clearly. A twentyfold increase in metabolic disorders followed abrupt changes, as against a more gradual approach. The effects of sudden changes appeared within a shorter interval the nearer the pregnancy. In the series referred to the effects of sudden change imposed not later than a month from pregnancy were manifest by disorders appearing 14 days later; when imposed nearer pregnancy 48 hours or shorter intervals between change and the precipitation of disorder had been obtained, especially after lambing—that is, when ewes were lactating.

Any comparative assessment of the influence of change must be related to pre-treatment. Methods of graduating change were well known and would surely be well discussed. Despite the palatability of spring herbage, most ewes would readily leave it to eat concentrate nuts; that was of assistance, therefore, in continuing supplementary feeding and graduating still further the initial change despite conditions of growth which, after a promising start, could cease temporarily and thereby induce a change in reverse from adequate supply to near starvation. Sheep were remarkably adaptable provided they were given time; but the time factor was less available with increasingly intensive methods of farming, and a greater degree of artificiality must be introduced to reduce the possibilities of sudden change.

The veterinarian in his own mind probably assessed the farmer as possessing a natural flair for stock or agronomy and crops. One of the practices of the farmer was the inclusion of old pasture (a balanced sward; not one over-grazed to the point of clover dominance and assessed as an old sward) with the ley. Experimental evidence, at present a little unwinnowed and unpublished, supported that practice in the control of hypomagnesaemia and hypomagnesaemic tetany in sheep. How and why was that?

Startling distinctions were sometimes observed between breed differences and the susceptibility to disorder under apparently similar conditions of management. Whilst the work of Benedict and Rickman showed that basol metabolism was to some extent determined genetically, there were other factors at work.

Mr. G. B. Stubbs said that the ketosis problem in ruminants had plagued the profession for a long time and the voluminous literature concerning the problem had, for the most part, been very confusing. Since reading Dr. Holmes's paper, for the first time he seemed able to some degree to examine in his mind one aspect of the problem without at the same time losing sight of all the other aspects. For that he thanked the author most sincerely and congratulated him on having produced a paper as clear and concise on so complex a problem.

Dr. Holmes stated in his introductory paragraph that, in ruminants, ketosis was encountered as a characteristic clinical feature in the syndrome termed "ketosis" or "acetonaemia" in the lactating cow and "pregnancy toxaemia" in the ewe; and he also wisely suggested it was of interest to speculate as to the possible cause of the symptoms. As the clinical symptoms of acetonaemia in the cow and pregnancy toxaemia in the ewe differed so widely in their manifestations, the syndromes of those conditions should not be grouped under the general term "ketosis."

There was little doubt that the clinical syndrome of acetonaemia in the lactating cow was a primary condition; but whether or not that state of affairs existed in pregnancy toxaemia of the ewe was a very different proposition. Here he disagreed with Dr. Holmes and suggested that the ketosis of this latter condition could very easily be of a secondary nature and that the primary condition evoking the initial clinical signs was of a totally different character.

In the Isle of Man, in general practice, one saw a reasonably high proportion of clinical cases of pregnancy toxaemia in lowland flocks and for the past few years the intravenous calcium therapy had been practised as a method of differential diagnosis, as suggested by Dr. Holmes.

Their technique and courage had improved—the intravenous administration of calcium borogluconate in sheep seemed to require some degree of technique and courage if it were not to be attended by disastrous results. They had adopted the anterior radial vein as the vein of choice and as much as 350 c.c. of calcium borogluconate could be administered through a flutter valve at controlled speed with little difficulty or danger. That is also an extremely simple vein to use for blood sampling in sheep.

As their technique and courage had improved, they began to find that a very impressive proportion of cases responded in a magical manner to this type of therapy, and the proportion undoubtedly increased when cases could be reported and treated when showing the earliest clinical signs and also when the volume of solution injected could be increased without performing immediate euthanasia. It was observed also that the subcutaneous administration of calcium borogluconate had little or no effect; likewise with intravenous administration in long-standing cases.

With the co-operation of Mr. Kerruish of the Isle of Man Board of Agriculture and Fisheries, and with the generous help of the Board of Agriculture, a small flock of lowland sheep were maintained at Knockaloe Experimental Farm with the object of inducing a condition of pregnancy toxaemia in ewes. It was rather remarkable to report that in spite of the fact that those ewes were brought to very fat condition in late autumn and early winter, and then placed on a lowered plane of nutrition as pregnancy developed, and finally fasted for several days in the terminal stages, only 2 animals out of 18 developed a ketomaemia and neither of those developed any clinical sign of pregnancy toxaemia. One produced dead twin lambs, poorly

nourished and small in size, and the second produced live twin lambs, also small and under-nourished. In fact, the quality of lambs from the whole small flock was poor due to apparent under-nourishment. Five ewes showed a marked drop in serum calcium levels in the last 4 weeks of pregnancy.

Shaw in America reported no visible symptoms of ketosis in a series of starvation experiments while blood levels of ketones were as high as in clinical ketosis. Shaw also reported ketosis established clinically without blood ketones being above normal. From this it might be suggested that the absolute levels of the various substances concerned in ketosis had no clinical significance except in relation to each other. It was at this point that the part played by the alkali reserves might be considered; and the possibility that the available reserve of free calcium ions having already been depleted by multiple pregnancy were further depleted by acting as a buffering agent to a point whereby the animal had reached a state of hypocalcaemia which, in itself, might account for some of the clinical signs of pregnancy toxaemia.

As Dr. Holmes had said, species analogy might be dangerous. He had described hepatic pain in the human subject and then drawn the analogy to account for some of the symptoms shown in pregnancy toxaemia. Mr. Stubbs asked to be permitted to draw a further analogy.

Browne writing on toxaemia of late pregnancy in the human subject described pre-eclamptic toxaemia and eclampsia: in that condition the clinical manifestations were a rise in blood pressure and hypertension, accompanied by severe frontal headache and dimness of sight. Was it not reasonable to suggest that those symptoms might also provoke the symptoms described by Dr. Holmes in typical cases of pregnancy toxaemia, *i.e.* standing with the head pressed against the wall, grinding of teeth, staggering, etc.? Was it also suggested that the acute symptoms of inability to stand and blindness might be due to cerebral oedema following hypertension? With the onset of those early symptoms it might be assumed that the affected animal ceased to feed, and following the general picture of ketosis, the nutritional intake no longer kept pace with the demands of multiple pregnancy and at this point the secondary ketosis arose.

Mr. Stubbs suggested that there were genuine grounds for further study to correlate the clinical symptoms of pregnancy toxaemia in the ewe along the lines of the relationship between a possible hypertension hypocalcaemia and secondary ketosis; and the possibility that in all cases of pregnancy toxaemia in the ewe large-volume intravenous calcium therapy by increasing alkali reserve, readjusting the hypocalcaemic state, and, by virtue of its hypertonic propensities, correcting the degree of oedema already established, was well worthy of trial.

The General Discussion

Mr. W. K. Hunter (M.M.B., Ilkley): "Mr. Hughes asked for information about hypocupraemia. My colleagues and myself, in association with veterinary surgeons in West Yorkshire and East Lancashire, have found the condition in several herds producing herd infertility. The herds are on farms where there is a programme of intensive grass production and the problems arose, in the main, in spring and early autumn. The areas mentioned, of course, have a high rainfall. The administration of copper intravenously resulted in the restoration of fertility in a spectacular manner.

"I am taken with Dr. Holmes's suggestion that we should breed for resistance to metabolic diseases, although this is another factor to add to all the other things for which breeders strive: milk, butterfat, conformation, etc. Perhaps the problem is more basic than that. Among those people who have done work on maintenance and production rations there is little agreement as to what a production ration should be, but Blaxter's work on the subject is probably the best to date. However, little work has been done on individual capability of food conversion. Surely the best food converter is the animal from which we should breed, all other things being equal, and taking into account that it must be from a fertile strain?"

Mr. D. W. Kerruish (Isle of Man): "Firstly, I should like to know whether Dr. Holmes is entirely satisfied that the condition which we know as twin-lamb disease is due to the presence of abnormal quantities of acetone in the blood. G. G. Thomson of New Zealand in an account of some research carried out on this condition gives the amount of acetone found in blood samples taken from field cases, and induced cases, during treatment. Four induced cases used as controls had just as much acetone at the end of 10 days' treatment, 1 had more acetone than at the commencement of treatment, yet all lived. In other cases under treatment the acetone levels fell from as high as 33.7 mg. per 100 ml. to as low as 1.8 mg. per ml., but these animals died. Others which did not show any great reduction the acetone level did not die.

"I should like to associate myself with the suggestion put forward by Stubbs that twin-lamb disease might be due to hypertension. What relationship exists between pre-eclamptic toxaemia and eclampsia in the human subject and pregnancy toxaemia in the ewe? G. G. Lennon of the Department of Obstetrics at the University of Bristol in a communication to *The Lancet* this year suggests that the human condition may be due to an inadequate intake of protein. He also states that the disease in the human subject may be controlled by a high protein diet. Inadequate intake of protein may lead to diminution in the amount of methionine from the liver necessary to methylate noradrenaline to adrenaline.

"Liver changes in the human subject appear to be similar to that which occurs in the ewe. Does kidney damage and hypertension occur in the ewe? Incidentally, I should like to know of a simple method of obtaining blood pressures in sheep in the field, if one is available.

"Some years ago we were told that twin-lamb disease occurred prior to lambing and hypocalceamia occurred after lambing. It may have been true then but it is no longer true to-day.

"We have noted here a marked improvement in locomotion and mentality in twin-lamb cases following the administration of a fairly large quantity of calcium or glucose intravenously. Animals after such treatment were prepared to eat provided the food was inserted in the mouth and were generally much brighter in appearance. This improvement was in most cases temporary.

"Could not hypertension be responsible for the liver damage as well as for the symptoms of the disease?"

Mr. J. W. Bruford (Sevenoaks): "I should like to thank the authors of the three papers presented this afternoon, and in particular I should like to congratulate Dr. Holmes on his contribution although, in my experience, heifers are not infrequently affected with acetonaemia.

"I cannot agree, however, with the conclusions drawn by Mr. Weighton in his paper. Unfortunately I have not with me the details of the trial which Dr. Marr and I carried out in 1957, but this was reported at the Cambridge Congress last year by Dr. Marr. I feel that had Mr. Weighton carried out his trial on Jersey cows he would have come to a different conclusion. Briefly, in our trials, approximately 20 Jersey cows on 2 farms were included: all 20 were expected to go down with milk fever, and every other animal due to calve was treated. All the controls had milk fever and most of the treated animals suffered from it too, but those which did not go down with milk fever refused their food, presumably because of nausea caused by the vitamin which had been drenched to them. Owing to the very bad results the owners would not allow the completion of the trial. I feel sure that this line of treatment is of no value in its present form."

The Replies

Mr. Hughes, in reply, said he felt that Mr. Michael should be asked to write a paper on the management of hill sheep. Mr. Michael had referred to food, shelter, shepherding, and all the things that were so essential on a well-run hill farm, and he agreed heartily with all he had said. There was, of course, the difficulty of putting ideas into practice. A major difficulty was that a hill farmer's capital was so often small.

In reply to Dr. Howell, the difficulty of distinguishing between entero-toxaemia and some of the metabolic diseases in sheep were fairly well recognised. The observation of

Mr. Hunter was similar to those of the speaker, who had also noticed an apparent connexion between infertility and hypocupraemia. One difficulty was that hypocupraemia was so common in many parts of the country that it was difficult to assess its significance as it was a background to many other conditions. It was certainly true that the infertility associated with hypocupraemia generally responded to treatment with copper. Mr. Hughes felt that Mr. Hignett probably appreciated the whole problem as well as anybody present because, in addition to his other qualifications, he was a farmer.

In reply to Mr. Hignett, who raised a question about the relationship between nitrogen and copper, Mr. Hughes said that he felt that in some areas the level of copper in the soil was critical and if the herbage output on such soils was increased by reseeding and applying nitrogen, the resultant increased vegetation would, in a wet year, lead to a deficiency of copper in the dry matter, as occurred with cobalt. It was against such a background that deficiencies existed in Wales, which the speaker believed had its own peculiar problems.

Mr. Wright had referred to the question of feeding for production. The speaker felt that there was a need to reassess some of the nutritional standards still being used. Some of these standards were made when the rôle of bacteria in the nutrition of the ruminant was little understood.

Mr. Weighton, in reply, said that one speaker in the discussion had been unfortunate in his experience with vitamin D, but since Jersey cattle were not very numerous in his own district he was unable to criticise severely what had been said. However, the work done in the United States appeared to relate to Jerseys. All the cases he had referred to in opening had had milk fever; he was sure of that before admitting them to the field trial. There was no difficulty in getting animals to eat vitamin D. There were, of course, certain conditions which had an adverse effect upon the usefulness of vitamin D as a prophylactic.

In reply to Mr. S. L. Hignett's question on the feeding of a low-calcium, high-phosphate diet, an experiment conducted by Boda involved 68 cows, 25 of which had previously had milk fever, and only 5 cows showed slight clinical symptoms of milk fever. On the matter of parathyroid glands, it was rather a question of fixing one's view along the lines of particular research workers in order to make a little headway. He himself had been supporting the theory which was originally advanced by Dr. Russell Greig and had the support of the American workers.

It was not common for a cow to have milk fever a considerable time after calving, but it did happen. It has been suggested that when this occurred the animals were fed excessively for high milk production. It was well known that a high protein ration would in some cases produce a hypocalcaemia which was not, strictly speaking, a milk fever. Cases of this type would probably benefit from an injection of calcium, but given time and other appropriate treatment a recovery would be made without calcium therapy. In a typical milk fever case phosphate was not really required. Finally, he would voice his feeling that they should not neglect the field of endocrinology in pursuing studies of metabolic disorder.

Dr. Holmes, in reply to Mr. Michael, said he agreed that shelter might be of considerable value in the prevention of pregnancy toxaemia in the ewe and acetonaemia in the cow. In a cold environment an animal had to utilise more food material for the maintenance of body temperature. One wondered whether modern cowsheds were always ideal in this respect. In a cold and draughty house the animal had to utilise food material to maintain body temperature which might have been more usefully employed in milk production.

A balanced diet was preferable to a predominantly carbohydrate supplement. Mr. Michael's observation that advancing pregnancy was associated with increasing fatigue and a reduction in rumen capacity provided a possible explanation for the development of some cases of pregnancy toxaemia. At *post-mortem* examination one was often impressed by the great volume of the abdominal cavity occupied by the uterus and the foetuses it contained. Resulting digestive disturbance might well be a factor in upsetting the balance between food intake and nutritional requirements.

The appearance of a flock was a guide to health but it was a delusion if one merely considered the fatness of a ewe, because fat on the back would not prevent the onset of ketonaemia, indeed the catabolism of fat in excess resulted in the accumulation of ketone bodies in the blood.

The contribution made by Mr. Stubbs illustrated very well the complexity of the problem of metabolic diseases in sheep and cattle. Particularly in pregnant ewes there were a number of metabolic upsets about which little was known. They all knew of cases which clinically appeared to be hypocalcaemia but did not respond to treatment. In the same way some cases resembling pregnancy toxaemia might respond to calcium, for hypocalcaemia could occur during pregnancy or after lambing. There was undoubtedly a very complicated inter-relationship between diet, blood minerals, and metabolic diseases in sheep which still required to be elucidated.

The symptoms of ketosis in the ewe and cow might appear to differ but a number of symptoms were common, such as partial anorexia, dullness, constipation, and in some cases nervous signs.

Mr. Stubbs described an experiment in which ketonaemia developed in only 2 out of 18 ewes subjected to interference in nutrition during pregnancy. It was not stated whether there was a high incidence of foetal mortality but it was agreed that the lamb crop was poor and under-nourished. When nutrition was inadequate the balance between food intake and production demands was not so easy to adjust in the ewe as in the cow. The cow was able to restore the balance largely by a reduction or cessation of lactation. In the ewe pregnancy generally continued and foetal demands gradually increased. It would seem that in the case quoted by the opener, foetal nutrition had been interfered with and thereby the ewes had saved themselves but the ensuing lamb crop had suffered. This was, however, unusual for generally the mother sacrificed herself for the foetuses.

A diagnosis of ketosis was not justified unless ketonaemia was demonstrated. Occasionally a pregnant ewe showed all the signs of pregnancy toxaemia but no ketonaemia. Such a case had probably been affected with typical pregnancy toxaemia but the lambs had died *in utero*, thus reducing foetal demands and relieving the ketosis. Often such ewes died of toxaemia from uterine putrefaction. If, however, one of the lambs survived the ewe might make both a biochemical and a clinical recovery.

Eclampsia in women was characterised by hypertension, albuminuria, and oedema. In the ewe albuminuria did occur. Little was known about the blood pressure owing to practical difficulties in its recording. There was no clinical evidence of hypertension for certainly oedema was not a feature of pregnancy toxaemia.

Whilst a secondary ketosis might develop in association with hoypocalcaemia in sheep pregnancy toxaemia was a typical example of a primary ketonaemia.

Mr. Kerruish, in an interesting series of questions, referred to the belief that in women eclampsia might be related to a protein deficiency. The same might be true of pregnancy toxaemia in the ewe. Certainly protein played an important part as well as carbohydrate and the ruminant largely maintained its blood sugar through gluconeogenesis. The liver lesions in the human subject were quite different from those in sheep. In woman the main feature in eclampsia was periportal haemorrhage which in severe cases resulted in the separation of liver cells in columns extending from the portal tract almost to the central vein, these columns being surrounded by blood or plasma. In the ewe fatty infiltration was the characteristic finding. This was physiological rather than pathological and if recovery occurred resolution was complete, the normal liver architecture being restored.

Changes were present in the kidneys in pregnancy toxaemia in the ewe. Fatty infiltration occurred in the cells lining the tubules. In some cases, but not in all, there were glomerular changes, characterised by swelling and increased cellularity of the tufts, protein extravasation into Bowman's capsule, periglomerular capsular fibrosis, and in longstanding cases sclerosis of glomeruli.

In the differentiation of pregnancy toxaemia from hypocalcaemia methods were based on: detection of acetone

in the breath; blood sampling for calcium and ketone bodies; and the effect ot test therapy using calcium borogluconate. The possibility of hypomagnesaemia had to be considered although this appeared to be more common in the post-parturient ewe and to be precipitated by a change of environment.

There appeared to be a higher predisposition in the Channel Island breeds. The exact reason for this was not apparent. It might be related to high level of production in relation to metabolism and the high fat content of the milk might be concerned. Mr. Wright observed that doubling the carbohydrate content of the ration had often reduced the incidence of ketosis in cattle. In herds feeding high protein concentrates this might have had the effect of producing a more balanced ration and reducing the stimulus to excessive high production provided by high-protein supplements. A great deal of work remained to be done on the composition of rations. It would seem reasonable to suggest that a predominantly carbohydrate ration would be most effective as a prophylactic, for there was a hypoglycaemia and a reduction in liver glycogen stores. It was, however, important to consider what happened to carbohydrate when it was ingested by the ruminant. The carbohydrates were all broken down by bacterial action with the production of lower volatile fatty acids some of which were ketogenic. It had been shown that if a normal cow was given very large doses of glucose (½ to 1 lb. per cwt.) by mouth, ketonuria could be produced. They must not lose sight of the importance of protein in the ewe during pregnancy and in the cow for milk production. The best advice was to purchase a balanced ration from a reputable feeding-stuffs firm with experience in the compounding of feed. It was doubtful, however, whether high-protein concentrate was desirable for it would tend to stimulate production and thus further upset the balance particularly in the recently calved cow.

A Practitioner's Approach to Skin Disease in Small Animals

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SUMMARY.—The factors influencing the condition of the skin, such as climate, breed, conformation, age and nutrition are discussed. The writer's personal method of examination and general treatment of the patient is described.

A method of clinical classification is suggested, followed by a discussion of the main skin condition of dogs and cats seen in practice.

There follows a brief review of skin conditions met with in the more unusual pets, small mammals, birds and fish.

WHEN I was invited by the Committee to give a paper to the B.V.A. Congress on the skin diseases of small animals, I accepted with some trepidation knowing that the subject is immense and my qualifications somewhat inadequate for the task. However, my interest in the subject made the task slightly easier, although I make no claim to have any specialised knowledge. My only possible approach to the subject is that of a clinician, and this paper is in the nature of a review.

Such a clinical paper must of necessity comprise the writer's own personal experiences and opinions, frequently unsupported by any real evidence of an accepted scientific standard, and this is likely to stimulate a good discussion from the floor. Such, I am sure, was the Committee's intention.

In the last 15 to 20 years, veterinary science has made astounding strides in the diagnosis and treatment of systemic disease generally, but unfortunately this does not hold for the diseased skin. Diagnosis is difficult, and treatment frequently empirical.

The classification and nomenclature of skin disease generally is difficult to follow, as different authorities classify and name a particular condition under entirely different headings. Later in the paper I shall attempt to classify the types of skin disease I have seen, in a form which I hope will be suitable to the clinician.

Factors Influencing the Condition of the Skin

Climate

The skins of certain individual dogs appear to react to the environmental conditions of the area and there is little doubt that the situation of a practice influences the amount of skin disease seen of a non-parasitic nature. High humidity and close proximity to the sea, that is low-lying ground, appear to be involved particularly. Sunlight in overdoses, or a sudden spell of hot weather usually brings in a crop of "skins." This is particularly noticeable in the spring. In my practice, situated as it is in proximity to the sea in a region of high humidity, with a considerable amount of strong sunshine, it is very noticeable that dogs coming to the area on holiday frequently show "eczema" soon after their arrival. I question the owner as to the previous history of the dog, and commonly find that at home the animal does not suffer from any skin affliction. It is known that, on the return home, the skin returns to normal. I have had many cases with persistent skin irritation which, when removed inland, will clear up without treatment and only recur when the animal returns to the seaside area. In the majority of cases the nutritional standard remained the same, so that I consider there is sound circumstantial evidence that climate does cause, or at least predispose to, the non-specific dermatoses of dogs.

Breed and Conformation

Many of the non-specific dermatoses may be attributed to abnormalities in structure both of the skin and underlying skeleton introduced in the course of selective breeding. To mention a few: abnormally short legs, elongated ear flaps and labial folds, entropion and ectropion, overdeveloped stop with deep crease, screw tails.

Unpigmented skin is extremely sensitive to radiation either from the sun or from electric fires, and I have seen cases which I consider were those of photo-sensitisation.

The type of coat which the dog carries is also a predisposing cause of pruritus and eventually of a dermatosis. Rough-haired Terriers appear to be the chief victims.

Age

With old age the skin becomes thickened, less pliable, and the hair becomes sparse. The metabolic rate falls and the absorption of minerals and vitamins from the gut decreases, so increasing the tendency to chronic dermatoses.

Nutrition

The relationship of the general level of nutrition to disease of the skin is vitally important, and equally important is the fact that any sudden disturbance in the general nutrition may precipitate skin abnormalities. Such disturbances may arise from sudden change from horse to cow meat, or a different brand of biscuit or canned food. As far as one can judge in such instances there is no specific deficiency.

Under normal conditions a real vitamin deficiency is unlikely to be present in the pet dog fed as it is to-day, but in kennel dogs and in cats there is undoubtedly a distinct possibility of such a condition arising.

There are, however, several causes of possible vitamin deficiencies:—

(1) *Inadequate food intake*
Ignorance of owner. Anorexia due to gastro-intestinal disease, infectious disease, toxaemias, operations and accidents.

(2) *Reduced absorption from gut*
Gastro-intestinal disease, liver disease, parasitism.

(3) *Improper utilisation after absorption*
Liver disease, diabetes mellitus, pancreatic disease.

(4) *Increased excretion*
Diabetes mellitus and diabetes incipidus nephritis.
(5) *Increased requirements*
Immaturity, pregnancy, lactation, exercise.
(6) *Therapeutic measures*
Diuretics.
Mineral oil.
Alkalis.
Sulphonamides.
Arsenicals.
Antibiotics

Mineral Deficiencies

Although experimental diets deficient in certain minerals produce skin troubles it is highly unlikely that under practice conditions such severe deficiencies occur as to cause skin lesions. A possible exception is deficiency of iodine. This may be associated with thyroid hypofunction.

Examination of the Patient

With monotonous regularity the skin case presents itself to the harassed veterinary surgeon. With so many different manifestations of non-parasitic skin disease there is a tendency to become bewildered. However, with experience, one develops a satisfactory routine examination and treatment for the majority of these conditions. As a rule it is not economic, or indeed necessary, to make use of the various laboratory tests. If, however, the cause of the condition is obscure or the treatment prescribed ineffective, or if there is a suspicion of parasitic disease, recourse to the skin scrapings, swabs, or even biopsy may be indicated, as may also be tests for systemic abnormalities. I do, however, make an almost routine use of filtered ultra-violet light, and it is surprising how many cases of microsporon infection have been picked up by this method.

It is essential that the approach to any skin disease is made with an open mind, with the realisation that the skin is another organ of the body, and that systemic disease is likely to influence the condition of the skin. To the younger practitioners I would suggest that they treat any suggestions made by their clients with suspicion, until at least they have made a detailed examination. Frequently, by wishful thinking or discussion with other owners, clients are convinced that a particular diagnosis applies to their dog.

To make a detailed examination of the skin it is necessary to have a good (daylight type) light. I do not myself use any artificial aid, except in certain circumstances when I use a skin magnifier, and I remove matted hair with scissors in order to expose the lesion satisfactorily. I then endeavour to give a name to the condition, using my own standard terms, which I, at least, understand!

It is necessary also to get an indication of the suspected cause, the duration of the disease, any previous treatment given by the owner, and, if possible, a detailed description of the appearance of the lesion at the commencement of the disease.

The breed, age and sex are naturally taken into consideration, together with any details of previous illness and/or accident, and the diet is discussed. If the patient is a bitch, the time of oestrus, pregnancy, etc., are noted. A general clinical examination is made, with reference to the history received.

General Treatment of Skin Disease

The reasonable treatment of any skin disease rests upon the detailed examination of the patient, the history and the clinical signs, using laboratory aids whenever necessary. In acute inflammation it is necessary to use medicaments which will not irritate an already irritable skin. Use of restraint or tranquillisers must be considered when pruritus or self-mutilation are evident.

In the process of returning the skin to normality all the modern therapeutic agents may have to be considered to ensure the use of those most likely to be of value. Local treatment is vitally necessary, but the possible necessity of systemic treatment must not be lost sight of. Advice how to maintain the skin and coat in a healthy state after treatment should not be forgotten.

In an attempt to simplify the classification of the various skin conditions seen in everyday practice I have adopted the following scheme, which is of necessity rough and ready. I appreciate that there are many, and perhaps serious, flaws in it from a purely scientific viewpoint, and even I myself find difficulty in classifying some of the conditions with which one is presented. However, it has the advantage of being simple, and in routine practice it helps to shorten the time and the extent of the examination.

(1) *Primary skin disease* (where the skin is the only organ involved).
Mange.
Ringworm.
Bacterial infection.
Conformation abnormalities.
Ectoparasitic dermatitis.
Trauma.
Burns and scalds.
(2) *Secondary Skin Disease.*
Endocrine.
Allergic.
Dietetic.
Systemic.
(3) *Conditions of unknown aetiology.*

In this paper I have not mentioned disease of the ear, neoplasms, or periorbital conditions, as these are usually dealt with separately.

In the remainder of the paper my intention is to deal with the various skin troubles which I have encountered personally, and only to discuss certain aspects of them which I have found interesting or effective.

Sarcoptic Mange Dogs

In every skin case I invariably rub the ear flap between my finger and thumb, and if there is a scratch-reflex I examine carefully until I find mange mites. Even if they are not to be found I *still* treat for mange. Lice will give the same reaction.

The diagnosis is sometimes difficult, particularly if the skin has been recently treated by the owner. It is advisable to take several scrapings from fresh

lesions. Direct smears are satisfactory if parasites are found, but if there is a negative finding from several samples the use of the sedimentation and flotation technique gives excellent results and can be carried out at leisure. These tests are surprisingly easy and the apparatus is available in all surgeries.

Treatment

In all cases of mange it is advisable to clip the whole body, or at any rate those portions around the affected areas. I have used tetraethylthiuram monosulphide 25 per cent. in alcohol, selenium sulphide, 0·1 per cent. B.H.C. emulsions and creams; but the method which gives me consistent cures is shampoo with B.H.C. in soap powder and dressing with 33⅓ per cent. as opposed to B.P. 25 per cent. benzyl benzoate emulsion. Four baths are given at weekly intervals, and dressing with benzyl benzoate is carried out in between. Active measures to prevent reinfection must be taken at all stages in the treatment.

Tetraethylthiuram monosulphide 25 per cent., even diluted 1:10, is toxic in pups, particularly long-haired breeds. In kennel dogs a prescription used with great success in both mange and ringworm is: ℞ Sulph. Sub. ℥viii, Ol. Rapi ℥viii, Ol. Picis ℥iv. Ol. Terebene ℥iv, Ung. Hydrarg. Fort. ℥iv.

This is applied every third day on three successive occasions, and then a bath is given one week after the last dressing. Eyes and scrotum are protected with bland ointment.

Demodectic Mange

Of the two forms seen, I am usually able to demonstrate mites more easily in the pustular form by simply squeezing the pustule hard until blood appears. It may be necessary to scrape the cavity. In either form it is essential to make very deep scrapings.

The local treatment I use for the squamous form is B.H.C. 0·1 per cent. cream well rubbed in every third day. On the intervening days an ointment of salicylic acid 3 per cent. (formula) is used, again by vigorous daily massage. The dog is washed with tetraethylthiuram monosulphide soap once a week and the dressing is continued for one month. After this period the daily application of either iodine ointment or colloidal iodine in oil is continued until the lesion heals or the owner is exhausted. The iodine is patted in, not rubbed, so that the new hair is not rubbed out.

Systemic Treatment

My routine treatment is the administration of arsenic by injection or orally. Injections of liver and/or vitamin A may be used if the response is poor.

Pustular Form

As a preliminary to treatment either I poultice with mag. sulph. and glycerine, or have several hot fomentations of conc. mag. sulph. solution applied. All the pustules are then gently evacuated by pressure. After 24 hours of this preliminary treatment, 0·1 per cent. B.H.C. cream with 0·1 per cent. proflavine is thoroughly massaged into the skin, and this is continued twice weekly. Between these dressings benzyl benzoate emulsion 33 per cent. is used, and the animal is bathed at fortnightly intervals. Recently I have used a selenium sulphide bath, and I believe it is more satisfactory.

Alternative treatment

Rotenone is useful, but tends to dry up the skin as it is an alcoholic solution. It may be more useful than benzyl benzoate, but my experience is very limited. The treatment is varied according to the client's circumstances.

Parenterally

Staphylococcal toxoid is useful when the condition does not respond to broad spectrum antibiotics. Extract of liver, or vitamin A may be injected as tonics.

Ringworm

The diagnosis of ringworm I find a very difficult and painstaking procedure. The Woods U.V. lamp is a great boon to the busy practitioner, but like so many scientific aids requires intelligent use. It must be used in a dark room. A positive fluorescence is definitely positive, but no fluorescence is by no means a definite negative as fluorescence only occurs with microsporon and one must be able to appreciate and differentiate the greenish-yellow diagnostic luminosity from the non-diagnostic luminosities so frequently seen. Samples of hair and skin scrapings are best viewed on black photographic paper.

There are several pitfalls if the examination is too casual; one often sees, for example, a distinct yellowish luminosity if the hair is stained with urine or discharge. Certain lesions where there is desquamation of epithelial cells show a blue-white fluorescence. The white hairs on the feet, again, often show a faint fluorescence. (The demarcation of an area of erythema is well marked under Wood's glass as is the yellow colour of the skin in mild jaundice). Even with the use of a Wood's lamp careful confirmatory microscopical examination is necessary. I find the frayed ends and the club-foot appearance of the hairs is the best microscopic evidence, although spores and spore sheaths may often be recognised.

Treatment: Dog

Usually the areas are discrete and can be dressed readily. I have the dog bathed in mercurial soap, the areas plucked, and a zone around each lesion is clipped whilst the dog is still wet. This I think reduces the shedding of spores. The lesions and the surrounding areas are dressed every third day with 1 per cent. eugenol B.P.C. with 0.06 per cent. phenyl mercuric acetate cream well rubbed in. After 3 dressings the dog is bathed and examined for fresh lesions under ultra-violet light. This treatment continues until a cure is obtained.

If the lesions are very numerous, the dog is clipped, after bathing, with fine number 0 head clippers, and a dressing of our "mange dressing" is applied every third day. Three dressings are given, and one week after the third the dog is bathed. Any remaining lesions are treated with iodine ointment 5 per cent.

Bacterial Infection of the Skin

The organisms I have found associated with bacterial infection of the skin are staphylococcus and streptococcus—usually a mixed infection. Unfortunately, the result of sensitivity tests to the various antibiotics have proved rather disappointing in my

hands. The majority of primary infections of the skin are in certain localised areas of the body.

Cellulitis

This condition is due to a mixed infection of staphylococci and streptococci, and occurs as a thickened pigmented area well demarcated from the rest of the skin. It is invariably found on the limbs. The skin is covered with pustules at various stages of maturation, and usually several sinuses. A thin, watery, bloody fluid can readily be squeezed out. The lesion is irritable, and the animal by constant licking keeps the skin moist.

Treatment

The general treatment includes a high protein diet with adequate fat and vitamin B complex. In the first instance 1 c.c. of vitamin A is given parenterally, and then weekly thereafter.

Systemic

Sulphadimidine, benzyl penicillin, or chloramphenicol or tetracyline are administered. All drugs are given in high dosage rates for a period of at least 10 days. Usually the sulpha drug is given with injections of one of the antibiotics. Alternatively staphylococcal toxoid is used, the dose being increased every third day until the reaction is severe, say ·5 c.c., 1 c.c., 2 c.c., 4 c.c.

Yatren vaccine was used formerly with good results and is well worth a trial.

Local

Chloramphenicol and gentian violet cream or iodine ointment may be applied with advantage. Recently, the best results have been obtained with ·2 per cent. nitrofurazone soluble ointment.

In many cases it is useful to inject into the sinuses an antibiotic cream. The intramammary antibiotics are suitable.

I have never found surgical removal successful, but in some instances laying open the sinus track and cauterising with silver nitrate has proved satisfactory.

Furunculosis

In this allied condition the pustules are more discrete and situated in normal skin, which surrounds each pustule or group of pustules. There is not the clear demarcation line.

It is rarely necessary to use systemic treatment unless the response is poor to local medication. The pustules are expressed, and an antibiotic ointment or ·2 per cent. nitrofurazone soluble ointment is used daily. The diet and vitamin A administration are as above.

I have only used the treatment of 100,000 units penicillin and ·5 gm. streptomycin at weekly intervals in furunculosis of the feet under general anaesthetic on one occasion, but it proved eminently satisfactory (Joshua, 1958).

A condition occurs in the foreleg usually, but very occasionally in the hind leg, which I believe to be a bacterial infection. The animal licks a particular area persistently, and the skin becomes raw and thickened. Eventually the circulation is so poor that the surface has a bloodless, yellowish appearance. Treatment is difficult unless it is practical to use a collar, as with bandaging the lesion spreads above the bandage, again due to persistent licking. Systemic and local treatment appear relatively useless, and the condition eventually resolves, only to break out again in a few months time.

Secondary Bacterial Infection

This occurs commonly associated with demodectic mange, and indeed complicates many other skin diseases. Vigorous treatment is necessary as the already diseased skin is less likely to respond to treatment. In such cases the choice of treatment is antibacterial rather than antibiotic.

Conformation Abnormalities

Dermatitis of Labial Fold

Invariably diagnosis is made by the objectionable smell, and the localised ulceration. Treatment consists of scaling the teeth and making any necessary extractions with systemic sulphonamide or antibiotic treatment.

Local treatment consists of cleaning with bicarbonate of soda solution and dabbing dry twice daily. Mercurochrome 10 per cent. aqueous solution is used. If there is no response to this treatment I cauterise with lunar caustic, and may change the paint to triple dye jelly.

I have had to excise only a very few cases.

Entropion and Ectropion

In both these conditions a dermatitis is set up, due in part to persistent lachrymation and constant rubbing by the animal. It is essential to deal with the primary condition. Ichthammol 2.5 per cent. and zinc oxide 2.5 per cent. eye ointment I find very useful applied to the eyelids several times a day.

Localised Dermatitis affecting the stop and above and below the screw tail

Treatment consists in washing the affected areas with sod. bicarb. solution, as I believe this mild alkali cleans the tender skin without damage and neutralises the apparent acid reaction of the discharge. In every case the area is dabbed dry and powdered with an astringent powder containing starch and zinc or chlorquinaldol 3 per cent.

Mild cases respond to this line of treatment applied twice a week. The intervals of treatment are correlated to the severity of the condition.

When secondary infection occurs as a complicating factor broad-spectrum antibiotic cream and emulsion or ·2 per cent. nitrofurazone soluble ointment have proved useful. However, all treatment is palliative, and surgical interference is rarely successful in my hands as the loose skin drops down again.

Dermatitis of the Feet

This is one of several conditions affecting the feet, usually in the " cat-footed " dog. In such cases I use soap and water to wash the feet and then powder with chlorquinaldol 3 per cent. I do not bandage, but use a collar to prevent licking, etc. Useful alternative treatment is liq. hammameledis B.P.C.

Trauma

This may be mechanical, thermal, or chemical. I do not intend to deal with the mechanical injuries as I have nothing to add to what is generally known and practised, except to stress that in the majority of skin diseases in animals self-inflicted trauma is a definite complicating factor.

There is a strong resistance on the part of clients to use the usual means (collars, muzzles, etc.) of combating this trouble, and recently I have been using, with a fair degree of success, the tranquillisers. Of these the best I have found are pecazine, benactyzine hydrochloride and chlorpromazine hydrochloride in that order.

Thermal Injuries

It is surprising that scalds do not appear to inconvenience the dog or cat for 2 or 3 days. It is when the blisters have ruptured and secondary infection has become established that the irritation commences. Such lesions are treated as wounds, after clipping the hair.

Chemical Injuries

In these cases clip the hair over the affected area, and remove the remaining chemical by washing with warm soapy water in the case of creosote, paraffin, or turpentine. Tar may be removed with ether, or by massaging in a bland oil, lard, etc., and then washing in soap and water. Lime is best neutralised with vinegar or very dilute acid followed by thorough rinsing. Lime may burn the mouth and pharynx as a result of licking.

Paraffin, turpentine and creosote may cause poisoning from the absorption through the skin.

Wasp Stings, Bee Stings and Adder Bites

In the majority of cases these are not very serious, but sensitive highly-strung dogs may show some shock.

Bee Stings. Remove carefully, avoid expressing the poison sac, and soak the affected parts with dilute alkali: liq. amon. dil.

Wasp Stings. Treat with dilute acid.

Snake Bite. Invariably the bite has occurred some time previously, and it is unnecessary to apply a tourniquet. The puncture should be identified, and a crucial incision made deep over the area. It is wise to consider the proximity of large vessels underlying the bite. I say this with feeling as I fell into this trap once, and my incision and the subsequent haemorrhage caused more concern than the bite. Pot. permanganate crystals well rubbed in the incision are excellent. Carbolic soap solution infiltrated round the area detoxicates viper venom but may cause ulceration.

Ectoparasites in Dogs

It would be invidious to say more than that, whenever there are skin symptoms in dogs, a search should be made for ectoparasites—lice, fleas, ticks and harvest mites.

Lice are usually found on the ear flaps even when scanty on the body, and it is always wise to examine the fold of skin in the posterior border of the ear flap, as a nest of lice may exist there although treatment has been given by the owner.

An infestation of larvae and nymphal ticks may occur in any area, and these are resistant to many common parasiticides. Pybuthrin has proved efficacious.

Fleas may cause severe pruritus, but this is not in relation to the number. A careful search of the predilection sites must be made and any black gritty faeces noted.

Thrombiculae.—These orange mites usually affect the head or feet and are readily seen when patients are examined for treatment.

Ectoparasitic Dermatitis

This condition, which I used to call dry or chronic eczema, is, I believe, far the most common skin condition met with in practice. It may vary from a dry scaly condition along the back, to an almost totally raw discharging area from the ears along the back to the root of the tail, extending over the chest walls and flanks. Pruritus is intense, so the damage to the skin is almost wholly self-inflicted. The lesions vary from erythema to " heat spots " and whole areas of oedematous raw skin.

Parasites, either lice, fleas or ticks, are always present, but sometimes there are so few that one must look for some other cause than the actual parasites themselves. This, I am sure, is an allergic reaction to the bites of the various arthopods.

At any stage secondary bacterial infection is likely to arise.

The treatment we use is periodic antiparasitic baths, clipping the dog if the coat is long. Lotions are used on raw areas and in the critical stages, followed by ointments when the acute phase has passed. Internally, arsenicals are given by mouth or by injection. Promethazine hydrochloride is the antihistamine of choice.

Endocrine Dysfunction

Imbalance or deficiencies of the endocrine glands frequently result in skin abnormalities. In the milder cases there is little alteration of the skin, but there is a persistent casting of the coat which may lead to slight baldness.

The functions of the endocrine glands are so complex and inter-dependent one upon the other, that any skin condition caused by the dysfunction of these glands cannot be ascribed to any particular gland entirely. This, I think, explains the rather unexpected results we get in the treatment of endocrine skin conditions.

After pregnancy or lactation there is usually a casting of the coat with some baldness which may be due in part to endocrine deficiency with or without a vitamin deficiency.

The main skin condition caused by endocrine upsets is alopecia which I understand to be non-infectious and non-contagious, where the hair falls out and the skin becomes smooth, velvety, and pigmented blue-black. There is no itching and the affected skin is cold to the touch. Invariably the condition spreads from the centre outwards, and is usually bilateral. It starts from the flank region, gradually spreads over the sides, and if unchecked over the trunk. The head, legs and tail often remain unaffected.

It is difficult to differentiate between alopecia of thyroid origin and that of the sex glands; but in hypothyroidism the alopecia develops around the neck, the thighs and perineal region, whereas in alopecia mainly of sex gland origin the alopecia starts in the flank region, gradually spreads over the lateral wall of the chest, and if unchecked to the whole trunk and tail. The head is rarely affected.

Hypothyroidism

The history is that the animal is adult, and has been becoming lethargic over a period otherwise relatively normal. Usually there is some degree of obesity. The pulse is slow and soft and there often is evidence of myxoedema.

Treatment

I commence with a dose of Extr. Thyroid Sicc. in the neighbourhood of 1 gr. daily per 10 lb. dog and take the pulse rate. At weekly intervals the pulse rate continues to be taken, and the dosage rate is increased until it is considered normal. When this stage is reached the dose is continued, the client by this time being able to take the pulse rate and report weekly. In the event of any alteration in this rate the dosage is reduced or increased as appears to be necessary. An occasional visit is all that is required to keep one informed of the patient's progress. Response is slow; usually 4 to 6 months must be given before a good coat growth is obtained.

I use thyroid and iodine capsules as I find I get a better response to this combination of drugs in this part of the country which is considered an iodine deficient area. These are used as a basic dose with the thyroid extract increased as required. Local treatment which I have found reasonably successful is 5 per cent. tetrahydrilfurfuryl nicotinic acid ester in water soluble base but any stimulating cream helps.

Alopecia due to Sex Gland Dysfunction

The alopecia in this case develops in the flanks as previously stated. The dog or bitch is adult, and may be prematurely senile. The sex functions are abnormal, the bitch showing anoestrus for long periods or suboestrus, whilst the dog shows a softening of the testicle with a dropping of the sheath due to excess fatty deposit above it. The normal sex instinct is absent or there is sex inversion. I have noticed, very frequently, increased nervousness.

The only treatment I have found successful is ovario-hysterectomy or castration. I have not attempted the Steinach's operation. In male dogs, after castration, I usually administer for a period of a month methyl testosterone 10 mg. daily.

Sertoli cell tumours of the testes may cause alopecia, and recovery takes place if these are removed. Cryptorchid dogs are frequently affected.

It must be noted that stilboestrol poisoning can lead to shedding of the coat, and even alopecia follows treatment for mesalliance in the bitch and in the treatment of anal adenomata in the dog. I have seen one case of severe alopecia associated with a large cyst in the ovary of a bitch.

Dermatitis of the Vulva

This condition is often very troublesome. The vulva is almost hidden by folds of skin overlying it. A reddish brown discharge accumulates and the irritation is marked by consequent licking, creating a vicious cycle. Treatment with stilboestrol ointment has proved more efficacious than oral administration. Cleansing with cetrimide and liq. hammamelidis lotion is useful. Some cases are very resistant to treatment.

Allergic Dermatosis

The dermatosis caused by the allergens of pollen and grasses I also used to include under the title of dry eczema. I am now convinced that allergic dermatosis is a clinical entity arising from a variety of causes—ectoparasites, bacteria, food allergies, and flower and grass allergies.

The condition may affect the entire body or specialised areas.

Sub-acute Allergic Dermatitis

The main area affected is the back, as in ectoparasitic dermatitis, and the condition resembles this complaint closely. The skin becomes oedematous and thickened, though there are no parasites found, and parasitic dressing does not affect the condition markedly. There is intense pruritus and the animal licks, gnaws and scratches continuously. There is another form affecting the under surface of the body in the form of an erythema and "heat spots."

Acute Dermatitis—Wet Eczema

This condition appears quite suddenly as a circumscribed, hot painful area, which oozes a thick glutinous discharge which mats the hair. If the dog licks sufficiently the hair is removed and the area has a yellow, weeping surface. There is a surrounding zone of hyperaemia. One rarely sees the vesiculation as commonly described.

As wet eczema occurs at any time of the year it is difficult to ascribe the condition to any particular cause other than self-mutilation, with the skin conditioned to an allergic state in some unknown way by a nutritional deficiency—protein, vitamin or mineral—and to some extent by the humidity of the atmosphere. Frequently, the cases which appear in the winter months are, in my opinion, due to lying close to a fire or living in an overhot indoor atmosphere.

I have noticed that certain poodles, after having their face clipped, develop a severe lesion over the masseter muscles, and no other lesions. Over this area there is a tendency to clip too close so damaging the skin. The lesion is caused definitely by the dog rubbing or scratching the jaws. Invariably these dogs are difficult to clip and very highly strung, and this in itself may condition the skin.

Treatment of Allergic Dermatoses

It is first essential that the animal is prevented from inflicting further damage, and measures must be taken to this end: a wide collar, hobbling or muzzling, and if such measures are impracticable the use of tranquillisers; pecazine or benactyzine hydrochloride are my choice.

The hair is clipped over and around the lesion so that the coat does not come in contact with the irritated area, and the lesion is cleaned with 1 per cent. cetrimide. The animal is given a saline purgative and the diet is changed or regulated, and if not already supplemented a small daily dose of brewer's yeast is prescribed.

Systemic Treatment

Acute type

An antihistamine is administered by injection and

followed by a course of the drug given orally. This may be supplemented by antibiotic or vitamin injections if the case appears to warrant them.

Less acute type

Arsenic in one form or another is a well tried and satisfactory remedy and may be supplemented again by antibiotics and/or vitamins.

Local Treatment

Acute type

In the first instance, after clipping and cleansing, chloramphenicol and gentian violet sprayed on the lesion appears to be very beneficial. This is followed by a soothing lotion such as calamine with witch hazel or some mild tar lotion. The choice varies, depending on circumstances. Bland ointments are used as the condition subsides.

Less acute type

Baths in sulphur or selenium sulphide are invariably prescribed, followed with a soothing lotion of tar or witch hazel applied frequently. In certain instances where the lesions are encrusted and not very extensive a bland antiseptic cream is advised.

In all these cases, whether acute or not, the choice of the therapeutic agent is a personal one and the action of it on any particular case cannot be guaranteed. Frequently, many different lotions and creams may have to be tried before a satisfactory agent is found. The hydrocortisone preparations are very useful in stubborn cases. The ointment is preferred to the lotion as it appears to be more efficacious.

Urticaria

This mainly occurs in the short-haired dogs such as boxers or dachshunds. It sometimes arises from insect bites, stinging nettles, and certain chemicals such as carbolic acid, etc., or it may be caused by the absorption of irritant substances from the intestine. The cause is frequently difficult to identify. Very rarely do you get any secondary type of urticaria due to intercurrent disease, but I have seen it occur in a line of dachshunds each time the bitch was due to come on heat. Sometimes the temperature in these cases is high, but rarely are there any other symptoms except intense irritation of the plaques, which are firm, flat-topped, with the hair standing erect. The development is rapid and may arise in anything from 5 to 30 minutes; it usually disperses in a matter of hours to days. It may be that the irritation is so severe that the dog mutilates itself and so causes a type of discharge over the swellings. This will be treated with the usual antiseptic and astringent lotion.

The treatment I find best is the antihistamines, one or other of the long-acting ones given parenterally in the first instance, followed twice daily with tablets. Local sedative lotions are used if the irritation is severe. Recently I have noticed that the condition may subside, only to reappear when treatment is stopped.

There is one interesting case which I quote:—

A miniature smooth-haired dachshund with urticaria showed bloodstained faeces, oedema of the lungs, and swelling of the larynx. The urticaria did not respond rapidly to antihistamine, but the syndrome subsided gradually. Treatment consisted of antihistamines both parenterally and orally, combined with penicillin and liver extract with gut sulphonamides to control any possible gut infection.

Serum Sickness

I have seen very instances in practice, and the one particular case I can remember caused more general distress to the animal rather than any affection of the skin, although there was a slight urticaria which was not irritable.

Dietetic

Although diet plays an important part in the production of skin disease generally, it is difficult to implicate as an exciting cause.

In young puppies, whilst suckling, an exfoliative dermatitis arises which I believe to be caused by a lack of vitamin E and the essential fatty acids. Since I have dosed them with ol. lini mg.ii and alpha-tocopherol mg.v daily for 3 days they seem to make an excellent recovery in the relatively short time of 5 days.

There is a mild alopecia affecting certain Toys and silky-haired dogs, occurring at 6 to 9 months old —when they are slipping their puppy coat. It shows on the legs below the carpus and hocks, and often on the tail and ears. The condition appears to benefit from administration of vitamin A. Invariably these animals show digestive upset and a slight discharge from the eyes.

In the older animal ol. lini 3i to 3iv, or margarine, containing as they do the essential fatty acids, have proved very useful when there is a slight scaling of the skin with some irritation, poor undercoat, and rather staring coat. They help markedly in the preparation of dogs for show. Local treatment is also given in the form of sulphur and selenium baths.

I have never seen a true case of nicotinic acid or riboflavine deficiency in a dog, but whenever there is an unnatural pinkness of the tongue and palate associated with any skin condition, large doses of vitamin B complex are given.

Several times I have seen a condition which I think is alopecia areata—small circular areas about half an inch in diameter in various areas of the body, slightly pigmented and with a degree of pruritus. This condition may respond to colloidal calcium 1 c.c. twice weekly with calamine and/or salicylic acid ointment applied locally.

Systemic Diseases

Diabetes mellitus is a disease with clear skin symptoms. I have seen cases where there was a marked exfoliative dermatitis with considerable irritation and baldness. In 3 recent cases treated with insulin the skin condition improved without local treatment.

Chronic nephritis causes a dermatitis under certain circumstances. Little can be done to alleviate either condition locally, but regulation of the diet helps greatly. Dogs which lick and chew their paws, causing a pedal eczema, frequently suffer from a mild nephritis, and I find by treating the nephritis the licking and chewing cease.

Liver disease and chronic gastro-intestinal disease invariably cause some skin symptoms; it is a moot point, however, whether these systemic diseases actually produce the skin symptoms by reflex irritation, or whether they in turn create a general vitamin deficiency either due to faulty absorption or excessive excretion of the vitamin intake. In all systemic disease where there are skin symptoms I prescribe a vitamin supplement, of which there are several on the market.

Conditions of Unknown Aetiology

There is a peculiar condition which crops up with fair regularity, attacking mainly young Alsatians between 9 and 24 months. The animal is thin, although the appetite is fairly good. The body functions are relatively normal, and on clinical examination there does not appear to be any intercurrent disease. The hair is sparse over the areas where there is not actual baldness, and there is an acanthosis around the eyes and on the muzzle, belly and legs. There is considerable pruritus. Examination for demodex is negative.

Treatment I have instituted is of little avail. Locally I have used benzyl benzoate, triethylthiuram hexochlorophene 2 per cent. soap, and various creams containing salicylic acid and tar.

Internally I have administered thyroid, male gland hormone, arsenic, and vitamin A and B complex. A case at the time of writing, that of an Alsatian bitch 18 months old, is being treated with triethylthiuram monosulphide and implants of testosterone 50 mg., and large doses, twice weekly, of liver extract and vitamin A. The diet has been altered to a high protein one with the addition of raw liver, and linseed oil given once a week with some improvement.

Frictional Acanthosis

This is seen mostly in fat dachshunds where the pigmented spongy skin occurs in the axillae and groin, spreading gradually over the underside of the animal. I cannot understand why this condition is termed "frictional." Whilst I appreciate that friction aggravates the skin condition as it spreads to areas where there is no possibility of friction, the cause must be more fundamental than this.

In my opinion the basic cause of the acanthosis is a glandular dysfunction; and as it occurs in both male and female there is a strong possibility that it is due either to the pituitary or to the adrenal. I am rather inclined toward the idea of adrenal dysfunction, as I have found ACTH and cortisone improve the condition somewhat. Unfortunately the expense of such treatment rather precludes its general use for prolonged periods.

Cocoa butter massaged into the areas daily, with twice-weekly dressings of a salicylic ointment help in many cases, and a cream with hydrocortisone ·5 per cent. and tar extract is excellent but expensive. Internal medication with arsenic in high dosage is also very useful.

Seborrhoea

This affliction of the skin invariably affects the whole body but is worse in those areas where the sebum does not dry readily: under the ear flap, in the stop with an overnose wrinkle, and in the axillae, groin perineal area, and in the legs and feet if there are folds of skin.

The coat is sparse or shed, and the skin is clammy and oily with a peculiar, rancid smell. Pruritus is not very marked but is present. The discharge dries to form scabs which are relatively adherent, and the skin, although slightly thickened, appears comparatively normal. Diet is important in the treatment of this condition; I invariably supplement with essential fatty acids and vitamin B complex. The internal administration of sodium thiosulphate 5-15 g. 3 times a day for 6 days seems beneficial, and in the few cases in which I have used it it seems to have made for an improvement.

Washing is carried out with hexochlorophene 2 per cent. soap weekly with a lotion of liq. hammamelidis, or if the skin is dry, cracking and thin, 2 per cent. salicylic cream. A useful product which in a few cases has shown promise is gentian violet 0·05 per cent. and alkyldimethyl benzyl ammonium chloride 0·05 per cent.

Photosensitisation and Sunburn

Occasionally one sees an unpigmented skin which is red and hot, with some thickening and only a mild degree of itching, but the animal resents handling. I am of the opinion that this is either sunburn or a photosensitisation. I have never seen actual vesicles, but after 4 to 5 days the skin scales and the condition subsides. It is noticeable that it occurs in dogs which have recently been clipped. Treatment used is an emulsion salol 1 : 80 in liq. paraffin.

Impetigo

Initially this condition arises in the form of red spots which erupt into circular superficial vesicles and subsequently become pustules which rupture. The discharge dries and forms a thin yellow scab. When this is removed a bald spot remains, and healing takes place with desquamation of the cells. Successive crops arise, and in any one animal the condition may be seen in all its forms. It used to be associated with distemper, but I believe it is due to debilitating factors which arise in puppies—worms, undernourishment, teething and intercurrent disease with a dirty condition of the skin.

Treatment is directed to removing the predisposing cause and consists of the administration of tonics and local antiseptic dressings.

Exfoliative Dermatitis

I have given this name to a condition I have seen recently and to which I cannot ascribe a cause. It arises in any part of the body and has occurred in a Labrador, Shetland Sheepdog and a Pekingese, all adult animals, one being a dog and two being bitches. Examination for ecto- and endo-parasites, ringworm, and mange were carefully carried out, but with negative results. The diets were checked and any possible deficiencies remedied. The histories gave absolutely no clue as to possible cause.

Internal treatment consisted of terramycin in high dosage with adequate amounts of vitamin B for 10 days. As no improvement occurred a course of arsenical injections was given. Local treatment consisted of astringent antibiotic and bacteriostatic

lotions and creams, and twice weekly baths in selenium sulphide. No adequate response was obtained. In the first case the condition eventually resolved spontaneously; the second case still under treatment but improving, whilst the third resolved with the use of an ointment containing neomycin, nitrofurazone, sulphacetamide, xylotox-glycyrrhetinic acid.

Biting of Legs, Feet or the Flank

There are many instances where, for no apparent reason, the animal licks or even gnaws a particular part of the body. I have seen several such cases over the years and they are usually put down to localised neuritis. In the days of distemper many more of these cases occurred after recovery from this disease. May I quote a few that I remember? A greyhound bit the end of its tail off. This was "cured" by amputation. A black and tan mongrel dog would for hours on end hold its flank in its mouth. This eventually resolved whilst on vitamin complex tabs, but was probably a spontaneous recovery. A female cat, after spaying, licked the dorsal aspect of the forepaws continuously until they were raw. Dressing could not be retained in place. This animal was eventually destroyed. As a student at the "Dick" I well remember a case of this type when the animal literally ate into its abdomen during one night. I cannot, however, remember the outcome.

Dermatitis Associated with Anal Glands

A persistent pruritus and dermatitis over the latter half of the spine running forwards from the tail root may be caused by septic or blocked anal glands. The treatment employed is local sedation and the glands are evacuated. In the event of this treatment not being effective the glands are filled with an antibiotic ointment (oxytetracycline), and if this fails the glands are packed under G.A. with paraffin wax.

In passing it should be noted that worm infestation may cause skin irritation due to the toxic effect of the parasites themselves, or to the effect they may have on the digestive system. One interesting case I remember was that of an adult mongrel terrier with a degree of alopecia. The animal was severely affected with tapeworms, and after eradication of the worms the coat improved spectacularly with no other treatment.

Scrotal Eczema

This is a peracute condition of extreme irritability with vesiculation, discharge and swelling of the subcutis. Whether the cause is allergic, systemic, or purely local—contact with an irritant such as motor oil, turpentine or paraffin—is difficult to say. It has been seen under differing circumstances such as in dirty urine-soaked kennels; following a case of urticaria; and just recently, subsequent to the administration of methyl testosterone in the treatment of a case of alopecia.

Treatment of Scrotal Eczema

The first essential, in treatment, is to prevent, by one means or another, the persistent licking which occurs in this condition. The hair is carefully clipped away and the discharge cleaned off. It is useful to use some form of sedation as the condition is extremely painful. Calamine and witch hazel lotion is used frequently until the discharge ceases, and then a mild calamine ointment is applied twice a day, thereafter, until the scrotum skin is normal. Recently, compound cortisone creams and lotions have been used, with outstanding success.

CATS

Mange may be Sarcoptic or Notoedric

The condition is usually seen in rather neglected cats, most frequently in "toms." This may be due to contact with stray semi-wild females. The head is mainly infected with small red papules with a tiny hard scab. The irritation is intense, and there is self-mutilation. If the case is of long standing the skin becomes bald, thickened, and ridged with a grey pigmentation, and there is a mousey odour. If the condition spreads through neglect there is anorexia, emaciation and lethargy. Diagnosis is similar to that in the dog.

Treatment

Cats are susceptible to many parasiticides, benzyl benzoate, tetraethylthiuram monosulphide, and DDT are definitely toxic, but derris, BHC and pybuthrin are well tolerated. The affected areas are clipped and the cat washed in derris shampoo. Then, every third day, one area of affected skin is treated with 1 per cent. BHC cream. Iodine ointment has proved very efficacious.

Demodex Infection

I have never seen, or at least diagnosed, this condition in a cat.

Otodectic Mange

This common condition in cats affecting the ears as parasitic canker, frequently spreads to the skin surrounding the ears and the ear flap.

Ringworm

If the infection is widespread destruction is advised, but if this is not agreed by the owner, and treatment is demanded, I have used with some success cadmium chloride 1 per cent. in aerosol applied to the entire body. Any lesions have been treated with undecylenate compound ointment. The wash is repeated weekly and the cream every third day. Instruments are sterilised by dry heat or flaming, and all debris burned. The owners are warned as to the probability of infection to themselves and the re-infection from contaminated bedding, baskets, etc. Anything that can be burned is burned, and furniture and carpets should be washed with a quaternary ammonium antiseptic.

Ectoparasites

Lice are rarely found in cats, but in kittens weaned early they may cause trouble.

Fleas

Cats are remarkably susceptible to flea infestation. The symptoms are an intense intermittent pruritus, when the cat will lick vigorously, usually over the back for a short time, and then stalk away growling, with tail twitching. On other occasions cats may sit with their mouths twitching and the skin over the loins twitching. In certain cats an actual fit may develop. If one runs one's finger down the spine the flea faeces may be felt as grit, and the cat will twitch

its back and jaws and frequently attempt to bite. At times we are asked what are the little white globules which are found often in the cat's bed, or it may be the owner suspects it of having worms as the larvae stage of the flea may be seen. I make no apology for this description of flea infestation in cats, as it is often missed entirely by the young practitioner and indeed some of the older ones.

Treatment

The best course is to bath the patient in a BHC bath and then to use the proprietary brands of anti-parasitic dust containing BHC, pyrethrum and pybuthrin once a week.

Tick infestation can be troublesome to cats. The adult ticks are touched with chloroform and removed, whilst I have found pybuthrin dust entirely satisfactory for nymphs and larvae. It seems to prevent reinfestation if used weekly.

As if the ectoparasites do not cause sufficient trouble in themselves, fleas, particularly, set up an allergic dermatitis which is synonymous with fish eczema or miliary eczema. A group of papules erupt on the back at the tail root and may spread up the back, even covering the whole body with the exception of the head. The irritation is intense, and by interference the lesion shows weeping areas and may become infected. A diet of fish may predispose to this condition, and the diet is altered if at all possible to oily fish—herrings or sprats—liver, offal, meat with a supplement of vitamin B. Biotin preparations are used if the cat will take it mixed with food.

A lotion of Liq. Picis Carb. 1/40 is used in conjunction with prednisoline ½ c.c. twice weekly. Arsenic as Fowler's solution is mixed with the food daily.

Thrombiculosis

These orange mites cause a marked degree of irritation. They are readily seen on examination, frequently in clusters around the edges of the ears, at the roots of the tactile hairs on the muzzle, masseter muscles, and above the eyes. If there are any eczematous lesions already present it is not uncommon to find them associated with these. They are readily removed by parasiticide dust.

Alopecia

This is relatively common in neutered cats, commencing at the back and inside the thighs and spreading over the lower abdomen. Some irritation and consequent licking may aggravate the condition. It responds well in about 3 weeks to implants of testosterone 25 to 50 mg. in neutered males, but may have to be repeated in 6 to 18 months. In neutered females stilboestrol implants have not proved successful in that many of them show persistent oestral symptoms, becoming emaciated. Minute doses, ¼ gr. every third day for 3 weeks, prove reasonably efficacious, but these require to be repeated periodically whenever the alopecia shows signs of returning.

Nutritive Deficiency in Cats

There is a greater chance of nutritive deficiencies in cats in the towns. Generally, it would appear that the most likely deficiencies would be vitamin A and B and essential fatty acids, with a possibility of methionine if the animal is on a whole meat or fish diet. The deficiency of vitamin A and B, and fat, may affect the cat by making it nervous and irritable, with mild stiff-legged inco-ordination of gait in the hind legs. I believe that this deficiency also conditions the skin to a state when any irritant, however slight, may set up an allergic dermatitis. Provided there are no parasites present the lesions appear as little vesicles which rupture, forming scabs which in turn disappear only to be followed by another crop. Administration of vitamin B may improve this condition, but the resolution is slow, taking several weeks to show improvement.

Animals other than Dogs and Cats

Nowadays, no paper on small-animals would be complete without some reference to the skin complaints of the lesser domestic pets, cage birds and fish. Unfortunately I cannot adequately deal with this subject, as it really requires a paper of its own. Many diseases will be missed entirely and only passing reference made to others.

Monkeys

Mange and ringworm have been seen in pet monkeys on more than one occasion. The symptoms exhibited resemble those in dogs and cats. Parasites are uncommon due to the ability of the monkey to clean itself, but lice may sometimes be seen on young or debilitated monkeys.

Wounds and ulcerations frequently occur, and due to the persistent removal of the scab by the monkey are difficult to heal. It is important that any medicament used must be non toxic.

Nutritional dermatoses are occasionally seen, and it requires great ingenuity on the part of the veterinary surgeon and owner to resolve these. Sexual alopecia has been seen in a female mangabey and treated successfully with progesterone implants.

Rabbits

Rabbit Syphilis.

The disease is caused by a spirochete *Treponema canicoli* and is characterised in the first stage as groups of papules on denuded areas of the skin of the external genital organs. Discharging ulcers follow the papules, and these may spread to the hock, the nose, lips and eyes following licking. In very severe cases the ulceration of the skin around the anus and uro-genital orifices make the voidance of urine and faeces difficult.

Treatment

Penicillin ½ to 1 c.c. daily for 5 days effects a cure. It is advantageous to use a sulphonamide cream on the lesion daily.

Mange attacks rabbits in two forms, psoroptic and chorioptic affecting the ears, and sarcoptic and notoedric affecting the body. Treatment is carried out as in dogs and cats. Although myxomatosis is not only a skin condition, there is a severe blepharitis and swelling of the various regions of the body and it must be mentioned.

Guinea-pigs

These do not seem to be prone to skin troubles. Lice, which cause continual scratching, have been seen only once.

Mice

Mouse pox, mange, and ringworm have been seen in mice colonies. Ringworm is usually seen on the tail, but may show as bald areas over the body. No treatment has been given, and destruction advised.

Mange was diagnosed on one occasion in a large colony, and the mice were sprayed with benzyl benzoate 10 per cent. in a wetting agent, and the sleeping quarters were dusted with flowers of sulphur. This outbreak was seen before BHC was available; many mice died and the colony was destroyed.

Mouse Pox

I have never been able to diagnose this complaint which I believe exhibits ulcerative sores with a thick adherent scab.

Hamsters

The only skin disease seen in a hamster has been mange, which was treated successfully with a BHC wash used with a tooth-brush in order to penetrate the coat. It was repeated weekly until 3 baths had been given and the original box was burned.

Foxes

Mange does occur, and is treated similarly to cases in cat. It is worthy of note that the fox sheds its coat very heavily in early summer, and this might be taken as a skin complaint by the uninitiated.

Ferrets

Foot-rot is common in this species, and is primarily a mange condition. The feet are swollen and scabby, and the claws may even drop off. The lesion extends up the legs to the body.

Treatment

Cleanliness and a dry floor are essential. The affected parts are scrubbed with a BHC wash twice weekly, and penicillin is given to counteract infection.

Birds

All birds seem to harbour innumerable ecto-parasites some of which are pathogenic and many non-pathogenic. However, it is wisest in practice to consider any of these as pathogenic and to treat birds with parasiticides. It must be remembered that the red-mite *Dermanyssus* does not live on the bird but only attacks at night, so it must be destroyed in the cages or lofts.

Nowadays, the introduction of the aerovap has solved the problem. This electric machine vaporises a tablet containing various parasiticides until the whole room, and the circulating air, are lethal to these pests.

Skin diseases seen in birds have included the poxes, alopecia, dermal cysts (feather cysts), soft moult in canaries, and french moult in budgerigars.

Reptiles

Snakes

Sloughing of the skin takes place periodically, and it should be shed in one piece. When it flakes off it is a sign that the snake is unhealthy. Any unshed skin, particularly that over the eyes, should be removed. It is wiser to soften the skin in water before attempting removal.

Lizards generally shed the skin in flakes, and it does not affect them to the same extent as snakes. Snakes, lizards and tortoises frequently are infested with ticks on arrival in this country. Such parasites are touched with paraffin (kerosene) and removed with forceps.

Mite Infestation in Snakes and Lizards

Small red or black mites may be seen, and the larval mites are seen as greyish white specks moving over the scales. Treatment used has been B.H.C. cream smeared over the whole snake. The cage is cleaned thoroughly and flamed if possible. All removable fittings are dealt with by burning.

Bacterial infection may follow the ectoparasites in the form of boils or ulceration, and before treatment it is advantageous to take a scraping and swab. Sulphonamide cream, furacin cream and various antibiotics have been used, sometimes with success.

Parasitic cysts may develop under the scales and ulcerate. These should be treated as infected wounds.

Toads

With some brow leaf toads an ulcerative condition develops affecting the skin of the nose, the feet and toes, and the back. Certain toes were pinkish and swollen, and ulceration occurred on the pads. In one case the bone was exposed. Examination of dead specimens showed that a monilia infection was present. The treatment consisted of painting the affected parts with terramycin intramammary cream, which fortunately contains polymixin which I understand is useful in this condition.

Fish

Fungus Disease

It is doubtful whether the fungus Saprolegnia actually attacks healthy fish, but it is commonly seen on debilitated or injured specimens.

If it appears on the body, paint with 10 per cent. mercurochrome or 5 per cent. methylene blue solution. If it is associated with the eye, paint with 1 per cent. silver nitrate solution. The fish should be isolated in a tank containing 1 per cent. dichromate of potassium for at least a week. The original tank should be sterilised.

Tail and Fin Rot. Mouth Fungus of Mollies and Live Bearers. Furunculosis and Gill Disease

These conditions respond to 500 mg. of terramycin per gallon of water. Renew the water with fresh solution of terramycin daily for one week: *i.e.*, remove half to one gallon daily of old solution, replacing with a like amount of fresh solution, and after one week continue using fresh water.

White Spot (Ichthyophthirius)

This parasitic disease is seen as white spots all over the fish. It attacks the fins, and then spreads over the body. The parasite can only be treated in the free living form. The procedure is to add 2 tablespoonfuls of common salt and 2 gr. of quinine to each gallon of water and raise the temperature to 85° F. Aerate well, maintain these conditions for 14 days, and then reduce the temperature slowly and replenish with fresh water gradually.

Acknowledgments.—The writer's thanks are due to his colleague, Mr. H. S. Mackenzie, to his secretary, Miss Pauline Gardner, whose assistance was invaluable, and to Miss W. M. Brancker, for encouragement and help in compiling the paper.

Reference

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THE SPEAKER'S INTRODUCTION

Mr. J. A. Dall, in presenting his paper, said that he had always thought that a speaker's introductory remarks were simply one method of letting the audience see, in the one case, the intrepid individual who, unknown to the majority of the profession, had had the audacity to present his views, in public, to his colleagues and, in the other, the expert—the backroom boy—who by his efforts in some research institution far from the glare of publicity, produced the results with which the practising veterinary surgeon could more ably serve his patients. Mr. Dall said there was no doubt to which category he belonged!

The other purpose which the introductory remarks served was to allow him, at any rate, to make some corrections and additions to the paper and to assure those present that he was fairly thick skinned!

On reading the paper over after the lapse of time between writing it and receiving it in printed form, it appeared to the author that in places he had been rather dogmatic, and he had no doubt the flaws in his assumptions would be pointed out. He apologised for the lack of references in the paper, but being a practitioner, the majority of the facts, ideas and treatments were carried in his head, gleaned from various magazines and from discussions with colleagues. Consequently he just did not know whence they came. Furthermore, he had not the library facilities nor the staff to look the matters up, even if he did know their approximate origin.

He expected to be taken to task for suggesting that climate influenced the condition of the skin, but he would be grateful to hear other views on that particular point.

The paragraph dealing with nutrition was not too clear. What the author had intended to convey was that the sudden change of diet was more detrimental than a deficiency of any specific factor in that the digestion was liable to become upset and, consequently, the effect shown in the skin. He had not mentioned that in his view excess protein caused a certain irritability of the skin with pruritus particularly in toy dogs.

Under the paragraph dealing with "General Treatment of Skin Disease" he had not stressed sufficiently the systemic treatment of the patient. Again, under the alternative treatment of demodectic mange one might wonder what the author really meant by "The treatment is varied according to the client's circumstances." That bore no relation of course to his pecuniary circumstances, but was really a question of whether the dog was a house or a kennel animal. In one instance it was necessary to use more cosmetic preparations, whereas in the case of the kennel dog he was inclined to use the old-fashioned "mange" dressing.

In the treatment of ringworm and bacterial infections the plucking out of the affected hairs was emphasised, although it was a tedious undertaking. It was often the deciding factor between success and failure.

The use of Yatren vaccine was suggested in the paper, but it had been discontinued, and any reference to the use of autogenous vaccines was omitted. That was a grave omission as specific and, indeed, non-specific vaccines did frequently prove very useful. He had not mentioned the use of the so-called vaccine ointments such as St. James's Balm and Antepeol. It might be thought that they were out-dated, but he had seen some spectacular cures with those ointments.

With regard to cases of endocrine dysfunction and skin trouble, he had a case of an Alsatian which appeared to be suffering from the similar condition to be found in middle-aged dogs—a certain amount of alopecia—and he had intended to treat it with an implant of testerone. He had not thought of asking the owner whether the dog had received any previous treatment. For some reason or other he ran out of implants and nothing was done for some time. On seeing the animal at some future date he found that it was cured. The owner said that the dog had gradually got better. It appeared that the animal had been given a stilboestrol implant for viciousness and that had cleared up the condition. It was therefore advisable to determine whether in such cases previous treatment had been given.

The Biotin used in the treatment of allergic dermatitis in cats could be obtained in an injectible form which might prove very useful.

Distemper in ferrets created a sweaty condition of the skin, but that was purely a secondary complication which cleared up if the primary condition could be cured.

With regard to mites in lizards and snakes, they could cause quite a deal of upset and could irritate the reptile to such an extent that it went off food and might die. BHC was reasonably efficacious, but treatment which had proved very successful was the dusting of the lizard with Pythurin powder. Salt water baths were used to loosen any matter under the scales. The treatment was found to be very satisfactory.

The Opener

Mr. E. F. Lewis, the opener of the discussion, was unable to be present at the meeting, and his contribution was read by **Miss O. Uvarov.**

Mr. Lewis said that the author apologised for a paper which, as he said, was in the nature of a review of his own personal experiences and opinions frequently unsupported by any real scientific evidence. He need not have done that since every person present must be grateful to him for trying to make a case for things he had actually seen. To one who spent his life in an academic atmosphere where nobody believed anything they heard and only half they saw, the author's clinical experiences came as a stimulating draught.

From the outset, Mr. Dall drew attention to the confusion which accompanied attempts to describe and to classify skin diseases. Efforts in that respect stemmed from the work of Hebra who was assigned to select skin cases from the patients of a chest clinic and founded that which might be termed the morphological era. In that period, the medical speciality of dermatology had evolved its own nomenclature and process of objective description. To one who attempted a study of that science the apparent entanglement of descriptive pathology and anatomy must stifle interest and progress. Thus in a standard textbook on dermatology one found that a simple skin condition, namely, erythema, was sub-divided into 24 high-sounding Latin types. They included Erythema Traumaticum, Venenatum and Nuchae. It would not be long before Erythema simplex gyratum caused Erythema Chronicum Migrans in the audience!

Fortunately the morphological era was being succeeded by the functional one, still in its beginnings but already responsible for great advances. Functional pathology amplified the static state, and in the course of the last 50 years brilliant work had been done on the behaviour of the cutaneous vascular system, the actions of acetylcholine and histamine, sweat mechanisms and skin temperature, skin micro chemistry and neurophysiolcgy, the allergic states and the field of bacteriology. Very little of that was of direct help to the busy veterinary practitioner, but it might be of comfort to him to appreciate that knowledge in that respect was as full of holes as a Gruyère cheese—sometimes more holes than cheese!

Mr. Dall drew immediate attention to the effect of a number of factors on skin condition. They included climate, breed, conformation, age, nutrition and mineral deficiency. Most people who had studied the problem would appreciate his views. There were, however, points for discussion. Presumably the high humidity plus warmth of a pleasurable seaside resort was productive of excessive skin probeclytic enzymes with resultant damage, but Mr. Lewis would perhaps have classified that with the hyperthermic conditions produced in unpigmented skin which the author called "photo-sensitisation." Perhaps he would reconsider that latter appellation. Mr. Lewis had always reserved the term "photo-sensitisation" for that condition in which there was absorbed into the body and so to the skin some photodynamic factor. That acquired energy from sunlight and caused oxidation reactions in skin cells with the release of histamine and the manifestation of the well-known syndrome. Was the author intending to suggest that such a dynamic factor existed in those cases, or was he willing to accept that direct solar irradiation was the cause?

Mr. Dall had crystallised general thought on the influence

of breed and conformation on skin condition when he suggested that abnormalities in structure, both of the skin and underlying skeleton, might have been introduced by selective breeding. It would nevertheless appear necessary for some accessory extrinsic or intrinsic factor to be present even in those cases for dermatoses to be set up. The term "non-specific dermatoses" always served to remind Mr. Lewis of his ignorance in an undeservedly subtle way. Perhaps the author would allow him to call them baldly "dermatoses of unknown aetiology."

Nutrition, as stated, was very important, but was it possible to differentiate between general nutrition and metabolism and the very local and delicately poised nutritional processes which were now known to go on in the skin itself? If one could accept that there was such a differentiation, those concerned might feel happier in their attempts to understand a very puzzling aspect of veterinary dermatology. It was only necessary to refer briefly to the work of Koeppenhoefer (1936) on skin lipoid chemistry, Földes (1933) and others on water balance disturbance and dehydration and a host of others investigating synthesis and metabolism of protein, vitamin, etc. The time must surely come when the skin was recognised not only as a reflecting mirror of troubles elsewhere, but as a very complicated busy organ in its own right with delicately balanced sensibilities. It was perhaps because of that appreciation that Mr. Lewis felt constrained to challenge the author's principle that "in the process of returning the skin to normality all the modern therapeutics should be utilised to the full." The older he became the more he was inclined to rely upon natural phenomena to cope with the pathological process, and he was very willing to let Mother Nature take the credit. That did not mean of course that he belittled in any way the many sound practical details of treatment elaborated by the author throughout his paper. Indeed, they had stood the test of long and successful usage. Mr. Lewis wondered, however, whether any skin treatment could stand the crucial test of experimental control.

It was gratifying that the author emphasised the value of simple laboratory aids to clinical diagnosis by his own example. He would have found no doubt that care in choice of site, material, time of sampling, etc., was a *sine qua non* to success with those methods. Sarcoptes were not always easy to find unless the case was just right with neat little papules being present under which lay the little blighters, as his good friend Mr. Sydney Jennings might so very aptly have said in his paper at the Aberdeen Congress on dermatology!

One could not quarrel with the outline of treatment for mange given in the paper, except to express a sort of general feeling that when he was actively treating cases himself, Mr. Lewis found that 2 or 3 applications of a watery suspension of crude benzene hexachloride containing all 4 isomers (it was much cheaper than any pharmaceutical form) saved the rather extensive treatment of the patient as suggested by the author and no doubt practised by others. After all, one needed *in principle* an efficient acaricide which would penetrate the epidermis. Sarcoptes did not as a rule penetrate to the dermis and in sections Mr. Lewis had found them rarely below the superficial layers of the epidermis. It should not therefore be necessary to badger the skin too much. Possibly the relief of itching was of prime importance in the prevention of what might start as a very mild local condition becoming a chronic dermatosis. The dermatitis produced, for example, by sulphur and other preparations was not infrequently mistaken for an exacerbation of the disease, and fuel was added to the fire by still more energetic applications. Perhaps the author or someone else would care to say a word or two on the method of application of the acaricidal dressing as well as on the materia medica of the treatment.

The author put forward what was to Mr. Lewis a novel method of treating the pustular form of demodectic mange. It had everything to commend it because it obeyed first principles of drainage, and no doubt the promotion of fluid loss by hygroscopic pressure was of great aid in the establishment of better skin mobility and function.

The remainder of the paper, and in particular the section on unusual pets, Mr. Lewis said he had read with great interest. From his experience there would be no dearth of questions from any veterinary audience whenever such a topic was discussed, and after congratulating the author for his very fine effort, Mr. Lewis invited the audience to add to the few remarks which he had been able to make and to ask their many questions.

The General Discussion

Mr. P. K. C. Austwick (Weybridge): "Mr. Dall's paper is a most useful contribution from the point of view of the laboratory worker who rarely has contact with affected animals. It well illustrates the necessity for more laboratory examination so that the veterinary surgeon in practice can use our increasing knowledge of skin diseases to the full extent. For instance, laboratory examination of skin scrapings from dogs during the past few years has revealed a condition prevalent in late summer which may well be an allergy to the fungus Alternaria, and this may eventually be distinguished as a clinical entity.

"So far as treatment is concerned, it seems likely that the only fair method of trial for therapeutic agents is by the use of experimentally induced lesions. Experience has shown that the interpretation of the results of clinical trials is extremely difficult and, in many cases, impossible."

Mr. S. Jennings (Glasgow): "I have not dealt with skin diseases for some years but as I was responsible for the term 'frictional acanthosis' I feel urged to comment upon Mr. Dall's reference to this condition. In the first place, we are never justified in using the term acanthosis just because a skin lesion resembles that seen in the human condition of acanthosis nigricans which is almost invariably associated with fatal multiple internal carcinoma. Acanthosis is a term used in histopathology to describe an increase of cells in the prickle layer of the epidermis.

"In the condition seen in fat Dachshunds where their legs rub on the chest wall there is an acanthosis present which can be recognised microscopically and the lesions appear on those parts of the body, and only those parts, where there is friction. If a dog is seen with some form of lesion of the skin in a position where there is no friction then it would be completely unreasonable to use the term frictional acanthosis, even if the macroscopical appearance of the skin resembled a condition seen in Dachshunds on the one hand or a condition seen in human species on the other.

"The essayist has stated that in wet eczema vesiculation is rarely seen. I am most interested in this statement and wonder if Mr. Dall would go one step further and agree, that if we avoid the use of the term eczema to cover a miscellany of skin lesions and use it only to cover that wet, highly inflamed area of skin which is so familiar to every veterinary surgeon, then vesiculation is never seen?

"In his paper Mr. Dall has referred to the use of arsenic. At one time arsenic was one of the few efficacious remedies that were available for the treatment of human syphilis. Arsenic often proved beneficial in undiagnosed syphilitic skin lesions and consequently came to be used for all kinds of skin conditions. I have never found it beneficial in animal skin disease and wonder if we are ever justified in using it for animals."

Dr. E. Cotchin (London): "It is possible, as an *aide-mémoire*, to classify lesions as being due to (a) inflammation, (b) neoplasia, or (c) neither. How did Mr. Dall find that skin lesions in dogs fell into this classification? More exact descriptions of skin conditions, such as alopecia, are needed, and histopathological research should be extended.

"Information is needed about the incidence of skin tuberculosis and rodent ulcer in cats, about the relation of benign and malignant melanomas in dogs, and about 'calcium gout' in dogs."

Miss O. Uvarov (Cobham, Surrey): "What is the speaker's opinion on the use of anticholinergics and corticosteroids in dermatoses in dogs? These are being evaluated in man and in animals. In certain cases of nephrosis, as well as in nephritis, dermatitis can be diagnosed. This can only be confirmed by urine analysis. In dermatitis of the vulva in

the bitch excessive acidosis can be responsible for such cases.

"I support Mr. Jennings's opinion on the use of arsenic, and the importance of diet in skin diseases.

"Has Mr. Dall had any experience of alopecia in Labradors along the shoulder region?"

The Reply

Mr. J. A. Dall, in reply to the discussion, referred to the question of photosensitisation and said he felt that solar irradiation did cause a certain erythema. Hyperthermia would occur in cases where an animal was prone to lie in front of an infra-red fire during the winter. He could not say that he had ever seen photosensitisation after the administration of any particular drug in the dog.

With regard to abnormal conformation, in the author's view it was the abnormal wrinkling of the skin in some way or other which caused that trouble simply from lack of aeration of the skin, and the discharges becoming rancid and causing irritation. He agreed with Mr. Lewis that Nature was probably as good a curative agent as anything else. There was no doubt that every effort must be made to attempt to help Nature rather than to hinder her, and to that end it was necessary to watch carefully that irritant substances were not applied to the skin unless for a particular reason. In many instances there was a tendency to over-treat skins, and frequently after a period of treatment, and when something had happened—such as the owner being ill—it was found that the animal had become better with no treatment.

Whenever monkeys had skin trouble it was usually the result of filthy, unhygienic and detrimental conditions. Every effort was made to improve conditions. The case of ringworm which the author quoted was in connexion with a rhesus monkey belonging to some people at Weybridge. It was diagnosed by a medical practitioner who was treating a child in the house. The author could not state what the spore fungus was. The great difficulty was that monkeys with skin lesions would not leave them alone. It was almost an occupational disease in that they picked the lesions.

With regard to rabbit syphilis, he had only seen one case and he gave ½ c.c. of Mylipen on every alternate day for 3 or 4 days. It cleared up quickly. He had never seen that streptococcus infection in hamsters.

As to French moult, it had been interesting to talk to one of the representatives at the Exhibition who quoted work being done by Mr. Taylor at Reading with regard to the effect of rather high protein diet on budgerigars which seemed to prevent French moult occurring. The administration of vitamin B complex raised the value of the protein digested, and either of those two treatments might have some beneficial effect so far as French moult was concerned.

On the question of reptiles, he agreed that the skin was more or less a thermometer. If the reptile had skin trouble it was definitely ill. Of course, so many reptiles lived under the most arduous circumstances in this country. In the author's view they were invariably "cooked." The infra-red lights were put on and the atmosphere was bound to become dry and the humidity decrease to such an extent that the reptile was almost roasted. Dehydration occurred. He felt sure that a bath in water did not prevent dehydration from an infra-red lamp.

With regard to tortoises, one often saw lesions round the soft parts, and he would treat them locally. He had not attempted to use vitamin B, but would do so.

He agreed with Mr. Austwick who said there was great difficulty in describing skin lesions. It was half the trouble that one veterinary practitioner would describe a lesion in his own words and another would describe exactly the same lesion, yet the two descriptions would bear no relation whatever, although each would know what the other meant. If more knowledge could be obtained on the histopathology of skin diseases, it might be possible at some time to describe them in a more or less concrete manner which could be understood by everybody.

Of course, nearly all veterinary practitioners would love to have more laboratory examinations, but there was a difficulty in that they were spread over the country, and a great deal of difficulty was experienced in veterinary practice in taking samples and despatching them and waiting 6 weeks for a reply. It was a difficult problem, but it could be solved and in his view it would be solved in the near future.

The fact of fungus causing possible allergic dermatitis in dogs and cats in the autumn was interesting. Skin troubles were expected at that time of the year, and it was quite possible that it might be a predisposing factor.

It was to be expected that Mr. Jennings would raise the question of frictional ancanthosis. When the author used the word "eczema" he meant acute eczema. Vesicles in the vesicular population were erupted in cases suffering from a chronic or low grade condition, but the author had never seen vesicles in a case of acute eczema.

With regard to sarcoptic mange, he had used the sugar flotation process and had found them after that when he did not find them on direct examination. He did not often use the process because nowadays he did not see much sarcoptic mange. The general level of nutrition of dogs had risen, people were more careful and were cleaner, and as a result less sarcoptic mange was to be seen. The ancanthosis was an interesting condition and the author did not understand it. In Dachshunds ancathosis was found, starting underneath the leg, but there was another condition which was definitely glandular. It was not associated with sex glands at all, but it was one where ancanthosis arose over the belly, in between the back legs and up to the inner side of the thigh. It started from around the vulva, without affecting the vulva, and went forward along the belly. That was the same skin condition as arose in frictional ancanthosis, but what it was, the author could not say. He could not cure it.

He did not agree that arsenic was useless in skin disease. He had used it for years. His clients were satisfied with it and came back for more. It was a tonic if nothing else.

Mr. Thomson had stressed the question of detailed description. If it had been stressed sufficiently and enough people read it, it was bound to make an impression on the profession generally. Mr. Thomson also mentioned a condition which was referred to under the section dealing with exfoliative dermatitis. The author did not know what it was or how it arose. It was an extraordinary condition. It arose in the first instance as a circular patch with a dark centre, and it gradually spread outwards. The hair fell out, and that condition could be very trying. It did not appear to affect the dog. Vioxel had cured the condition, but how, the author could not say.

In reply to Dr. Cotchin, probably the majority of skin complaints, whether parasitic or non-parasitic, were inflammatory in effect. The author had omitted neo-plastic conditions because he felt that he had enough to deal with.

He seemed to have fallen down badly in regard to tuberculosis in the cat, because he had never diagnosed it. On the question of rodent ulcers, they seemed to have disappeared recently. He had not seen a rodent ulcer for years in a cat, but it used to be common. The last treatment he used for that complaint was stilboestrol. The best thing to do was to cut the canine tooth.

The author did not agree with interfering with tumours unless they caused trouble. He had never seen the condition quoted by Dr. Cotchin in Alsatians.

In reply to Miss Uvarov, boiled milk was quite effective. He had used it when he could think of nothing else. He had never encountered the condition mentioned by Miss Uvarov in Labradors of alopecia of the scapula. He was grateful for the suggestion that vulva dermatitis might easily be caused by very high acidity of the urine. That point was missed in the paper. He had come across it and had treated the dog in order to make the urine less acid, and it had improved the condition. There were certain instances where it was almost an infantile condition of the vulva, and there was abnormality of the skin condition when the discharge became putrid.

He was convinced that cortisone had a great part to play in the treatment of skin conditions in small animals. The improvement that could occur by the use of those prepara-

tions was fantastic, but until the drug firms showed more realistic approaches to the matter and reduced the price to within a reasonable range, it could not be used to any great extent. The vehicle in which the cortisone was produced was almost as important as the cortisone itself. He had used the human skin lotion, but it did not work half as well as ordinary ointment. If a veterinary practitioner found a cortisone preparation which worked, then he should stick to it until something better became available.

Finally, the author made a plea for someone somewhere to start some form of recording of skin conditions, because unless the profession worked as a whole on the problem it would simply be a case of going round in circles and getting nowhere.

Salmonellosis in Animals

BY
A. BUXTON
Department of Veterinary Pathology, University of Liverpool

The Occurrence of Infection

Historical

THE history of the bacteriology of Salmonella did not commence until the end of the 19th century, but the clinical descriptions of fevers in man were described and published by Prost in 1804 and by Petit and Serres in 1813. In 1829, Louis first gave the name " fièvre typhoide " to these human infections. It was not until later that Eberth (1880, 1881) observed " typhoid bacilli " in infected tissues and that Gaffkey (1884) first succeeded in isolating the causal organism by cultural methods. At about this time, in England, Klein had studied the disease of hog cholera to which he gave the name " pneumo-enteritis of pigs," and during 1885-86 Salmon in the U.S.A. isolated and described in detail *S. cholerae suis* (see Thoinot & Masselin, 1899). Following this, many related organisms were isolated and given various names by different workers, including *S. typhi-murium* (*B. typhi-murium*, Loeffler, 1892; *Bact. aertrycke*, de Nobele, 1898; *B. pestis caviae*, Wherry, 1908; *Bact. psittacosis*, Nocard, 1893), *S. abortus equi* (Kilborne, 1893; Smith, 1893), *S. bovis morbificans* (Basenau, 1894), *S. gallinarum* (*B. sanguinarium*, Klein 1889), *S. pullorum* (*B. pullorum*, Rettger, 1900, 1901, 1909), *S. paratyphi A* (Gwyn, 1898; Schottmüller, 1900, 1901), and *S. enteritidis* (Bacillus of Gaertner, 1888).

Early in the 20th century there was great confusion as to the relationship between these various organisms because the properties and characteristics of some of these strains had been imperfectly described. In 1893, Theobald Smith and Moore noted a similarity between the so-called hog cholera bacillus, the bacilli of the Gaertner group and *B. typhi-murium* (Loeffler). Following the lead of Lignières that the hog cholera bacillus should be named Salmonella, a number of people suggested that other similar organisms should also be classified as Salmonella. Detailed studies of the antigenic structures of these organisms began to be made, but the S→R variations of the somatic antigens the results were confusing until the importance of (White, 1926) and the diphasic nature of the flagellar antigens on some serotypes was understood (Andrewes, 1922, 1925). It was not until the publication of the report of the International Association of Microbiologists in 1934 that the position was clarified. A sub-committee of that Association recommended the adoption of the terminology introduced by White (1929a, b) and modified by Kauffmann, which recognised the generic status of the Salmonella group and the specific rank of each of the antigenically distinguishable types.

During the last quarter of a century the amount of published data on the genus Salmonella has greatly increased. Certain aspects of the subject, such as the development of selective media for isolation and the serological identification of antigens, have been and continue to be investigated with great thoroughness. Meanwhile, an understanding of other aspects, especially the pathogenesis of disease, have not been maintained at the same level. There is the risk that from this uneven advance in knowledge, the true picture of the significance of Salmonella in the animal kingdom may not be appreciated. With this thought in mind, the subject is discussed in the light of more recent knowledge, with particular emphasis on the pathogenesis of infection.

Contemporary

The results from the wide use of improved methods for the isolation and identification of Salmonella have been the apparent increase in the incidence of these organisms in animals and the ever-growing variety of serotypes, based on detailed serological studies of the somatic and flagellar antigens. Some 350 serotypes are recognised and the majority of these have been associated with animal infections. Moreover, new serotypes are being added annually to this extensive list; and it is apparent that, with few exceptions, there is little host specificity—the majority of serotypes being potentially pathogenic to man and animals alike. This is the complex problem which faces the veterinary profession to-day, and it is of concern to those engaged in large- and small-animal practice, to those working in diagnostic and advisory services, and to those engaged in food inspection and public health.

Salmonellosis in animals occurs in all parts of the world. There are, however, some important and consistent features about the comparative incidences of various serotypes in these hosts. For example, while it is now known that the occurrence of Salmonella among poultry is relatively high, and is associated with a very wide variety of serotypes, it is significant that the majority of outbreaks are still caused by relatively few serotypes, being confined mostly to *S. pullorum*, *S. gallinarum* and *S. typhi-murium*. This state of affairs is a continuing reflection of the history of these infections and it forms the basis for epidemiological studies and control measures. From time to time, other serotypes may temporarily predominate in a particular district or country; as was the case of *S. thompson* infection in the United Kingdom (Gordon & Buxton, 1946), and of *S. niloese* in Denmark (Karlshoi & Marthedal, 1949). In the U.S.A. a wider variety of serotypes have been isolated and of these *S. oranienburg*, *S. bareilly* and *S. montevideo* are examples of some of the more common. Many of the serotypes

isolated from poultry throughout the world have not been associated with clinical disease or have been confined to only one or two outbreaks in young birds. For the most part, these latter organisms are not of major economic importance to the poultry industry.

Pigs are also known to be common carriers of Salmonella and many serotypes have been isolated from these animals. However, the majority of clinical infections are confined to *S. cholerae suis* and *S. typhi-murium*. As in poultry, this is a retlection of the history of this disease. Similar circumstances occur in other animal species in which the burden of clinical infections is associated with few serotypes. Among cattle, the common infections are *S. dublin*, *S. typhi-murium* and *S. enteritidis*; those in horses are *S. abortus equi* and *S. typhi-murium*, and those in sheep are *S. abortus ovis* and *S. typhi-murium*.

From this overall picture it is apparent that, for the most part, the world problem of salmonellosis in farm animals is associated with *S. typhi-murium* and the relatively few host-specific serotypes. The significance of the latter varies according to the type of farming and animal husbandry which is practised in different countries and climates, and also to some variation in the apparent incidence of these serotypes in different continents of the world. Although these brief generalisations may tend to over-simplify the situation, it is important to be able to appreciate the significant features of this complex picture of the susceptibility of animals to hundreds of Salmonella serotypes.

The Development of Infection

The fundamental aspect of Salmonella infections in animals is the mode of disease production and the real cause of death in those animals which become fatally infected. The position is complicated by reason of the variety of animal species which are susceptible to this disease and the differing methods of animal husbandry which may affect the spread and development of infection in a group of individuals. The development of disease may be affected by so-called predisposing factors which tend to increase the susceptibility of a host to infection, and also by the immunological response of the individual. It is a typical feature of clinical disease produced by Salmonella that fatal infection results from bacterial invasion and rapid multiplication in the tissues; a development which is obviously unfavourable to the continued survival of the parasite. Much is known of the circumstances which may increase the predisposition of an animal to fatal infection, although knowledge of the biological factors involved is still an open field for research. Intensive methods of rearing groups of young animals where individuals are kept in close contact with one another, increase the risks of infection spreading throughout the group. Young animals are more susceptible than adults, and these conditions are especially important among pigs, poultry and laboratory animals. It is generally agreed that the common route of infection is by ingestion, but among young chicks the inhalation of infected droplets may also occur soon after hatching. Recently, it has been shown by Moore (1957) that the conjunctiva may be a portal of entry among guinea-pigs, and similar results have been obtained from pullets infected with *S. gallinarum* (Harbourne, 1958).

Nutrition may have a significant effect on the susceptibility of animals to Salmonella infections; the exact nature of this relationship is not clear, but may be associated with factors concerning the development of immunity in the host and alterations in the virulence of the infecting organism. For example, *S. typhi-murium* infections in mice can be provoked by feeding a diet deficient in calories, protein, thiamin, riboflavin and biotin, but the authors believed that this may have been caused, in part, by impairment of humoral antibody response (Guggenheim & Buechler, 1946a, b). Bacon, Burrows and Yates (1951) found that the feeding of purines and p-aminobenzoic acid enabled an avirulent strain of *S. typhi* to become virulent. Doneddu (1940) demonstrated the increasing consumption of vitamin C by Salmonella grown in suitably enriched media. Hill *et al.* (1955) and Hill and Garren (1955) recorded that the resistance of chickens to infection with *S. gallinarum* was increased by a high level of vitamins and protein in the diet. With the exception of one group of birds, however, Chubb, Gordon and Tucker (1958) were unable to confirm these results, and they pointed out that different breeds and strains of birds may show variations in natural resistance to infection in experiments of this nature. These and other results confirm the importance of nutrition in the control of infections, but do not give very precise information on the relationship between the two. Present evidence points to the possible significance of the effect on the metabolism of the parasite in the host, which together with the immunological status of the animal will be decisive as to the final outcome of infection.

Virus diseases may increase the susceptibility of an animal to Salmonella infection, and such a relationship between swine fever virus and *S. cholerae suis* has been known for many years. Similarly, distemper virus may increase the susceptibility of dogs and ferrets to Salmonella infections, and the use of pigeons for the preparation of pox virus has resulted in the development of salmonellosis (Shirlaw & Iyer, 1937). There have been a variety of similar observations made in different animal species, and it is interesting to recall the controlled experiments of Ballowitz (1943) on the relationship between influenza virus and Salmonella. He showed that compared with suitable control animals, Salmonella infection in mice developed a more widespread distribution throughout the body of those animals which were also infected with P.R.8 strain of influenza virus.

As mentioned earlier, the development of fatal infection with Salmonella is dependent upon the ability of the organism to invade and multiply in the tissues of the host. The time required for this to occur in newly-born animals of various species is relatively short and death may supervene in the majority of cases 7 to 10 days after infection. In

groups of older animals the incubation period shows a wider variation and may, in fact, result in the development of many symptomless carriers, in which infection becomes confined to certain selective sites in the body. Many other individuals may successfully and rapidly rid themselves of disease. Apart from nutritional factors, these variations in the development of infection have been ascribed to a number of causes, including the size of the infective dose, the immunological status of the host, and the virulence of the organism. Oral infection of animals with a virulent strain of Salmonella results in the penetration of the intestinal wall and the development of primary foci of infection. It is from these established foci, in which bacterial adaptation to the micro-environment in the host's tissues may have taken place, that severe bacteraemia will develop. Generalised infection will occur only with those organisms which can adapt themselves successfully to their environment—a process which is not dependent upon the recognised antigenic structure of the organism (Maaloe, 1948). In an attempt to understand more concerning the invasion of the tissues by bacteria, Berry and his colleagues have recorded some interesting experimental results on infections in mice with *S. typhi-murium*. They found that injections of sodium malonate, sodium arsenite or sodium fluoracetate in sublethal doses caused more rapid death in these mice (Berry & Mitchell, 1953a, b). They concluded that this was due to the blockage of the tricarboxylic acid cycle and to the accumulation of citric acid in the tissues. In further experiments, Berry *et al.* (1956) found that at death a relatively constant viable population of *S. typhi-murium* was present in the mice. The time taken for the development of this population was variable and depended upon such factors as the size of the initial dose and the immunological status of the mice. The significant feature of these results is that irrespective of the time taken for the development of bacteria to occur in the tissues, sudden death took place once a particular maximum of viable bacteria had been attained in the tissues. It should be remembered that in such mice which succumb to infection the count of viable bacteria is not necessarily a measure of the total amount of endotoxin released from the breakdown of bacterial bodies during the build-up of infection; neither does it take into account the extent to which liberated endotoxin may have become neutralised or destroyed by the immunological apparatus of the host.

Various experimental approaches have shown the direct relationship between the presence of Salmonella endotoxin and the production of disease. For example, animals can be protected from clinical infection by immunisation with the endotoxin, and rough strains of *S. typhi-murium* and *S. gallinarum* which possess little or no endotoxin are not virulent. The experimental study of the capacity of endotoxin to cause pathological conditions includes the production of pyrexia, leucocytosis, hypoglycaemia, diarrhoea, anaemia, anoxia, prostration and death. These reactions are not specific to these endotoxins and similar effects may be produced by other gram-negative bacteria and by polysaccharides derived from non-bacterial sources. The extent to which these effects may be produced would appear to be dependent upon the quantity of endotoxin available. In a series of interesting experiments on *S. typhi-murium* infection in mice, Hobson (1957a) has compared the abilities of a streptomycin-resistant and a streptomycin-sensitive strain to produce fatal infection. These experiments confirmed the observations of Berry *et al.* (1956) that there is a critical population of bacteria which will result in death of the host. In addition, however, Hobson found that although this population was similar for both strains, the time required for the attainment of this critical population was markedly shorter in the case of the streptomycin-sensitive strain: in other words, this strain was able to multiply more readily in the host than the less virulent streptomycin-resistant strain. Moreover, the two strains appeared to be antigenically identical. This capacity of an organism to multiply rapidly in the tissues—a major determinant of a virulent strain (Pike & Mackenzie, 1940)—would not appear to be related solely to the somatic antigen but to some additional factor or property of the living organism. Organisms in the smooth phase may vary in their ability to produce disease depending on these other properties associated with their capacity to multiply in the host. This has become apparent from the work of those who have examined the limited immunogenic properties of Salmonella in connexion with the Vi antigen of *S. typhi* (Felix, 1952), and the greater immunising properties of live compared to dead vaccines prepared from various Salmonella serotypes (Iwahata, 1953; Ushiba *et al.*, 1954; Smith, 1956a, b).

At the present time information on factors, other than endotoxins, which are directly concerned with the ability of a strain of organisms to multiply in the host, is limited to a few observations on bacterial metabolism. As pointed out by Robb-Smith (1957), it does not follow that the metabolic characters of a micro-organism grown on artificial media are those which it reveals when growing in the hosts' tissues. It remains for further research on the metabolism of micro-organisms in the host to reveal those properties of bacteria which are of significance in relation to rapid multiplication in the tissues.

The development of bacterial infection in the host is related in part to the immunological response of the individual. In detailed studies of *S. typhi-murium* infection in mice, Hobson (1957a) observed that survivors developed a significant resistance, and that this was not associated with the serum titre against the endotoxin. Immunisation with an avirulent strain gave relatively strong immunity compared to the use of a killed culture, and lasted for as long as the vaccine persisted in the host. These results are in agreement with other similar observations, which confirm that the interpretation of serum antibody titres may indicate the presence of infection or of recent infection, but do not accurately foreshadow the future relationship between host and parasite.

During the last few years, successful techniques have been evolved for the adsorption of antigenic substances derived from a variety of bacteria on to

the surfaces of red blood cells. Polysaccharide extracts from Salmonella can be readily employed in this manner (Fulthorpe, 1954; Spaun, 1951, 1952), and modified erythrocytes are more sensitive than corresponding bacterial suspensions for the detection of serum antibodies. The application of this technique to observations on the appearance and concentration of antibodies in sera of birds infected with *S. gallinarum* reveals the high titres which may be produced soon after infection, and gives further emphasis to the absence of a close relationship between serum antibody titres and immunity.

The readiness with which bacterial polysaccharides will become adsorbed *in vitro* on to the surfaces of red blood cells must be considered in the light of the pathogenesis of infection. During the development of a fatal bacteraemia, quantities of endotoxin liberated from bacteria will be potentially capable of producing the various pathological conditions already described. Landy *et al.* (1957) have shown that fresh human serum will neutralise the toxic properties of these substances, and that this neutralisation is unrelated to the presence of antibody, complement or properdin. More recently, it has been found that normal serum similarly inhibits the adsorption of polysaccharides on to the surfaces of red blood cells. In a series of experiments (Buxton, in press) it has been noticed that in the presence of chicken sera this inhibition of erythocyte sensitisation by the endotoxin of *S. gallinarum* can be overcome provided that sufficient concentration of endotoxin is present. Moreover, there is experimental evidence to show that such a saturation point may be reached in those birds which suffer from acute bacteraemic infections with *S. gallinarum*, since the presence of bacterial endotoxin can be detected on the surfaces of circulating erythrocytes. The occurrence of abnormalities of red blood cells with Salmonella infections of man and animals has not been generally recognised, but there are, nevertheless, several references in the literature associating the two. Typhoid fever in man may be accompanied by an acute haemolytic anaemia (Flandin, Bernard & Mallarmé, 1935; Berman, Braun & Rachmilewitz, 1945) and haemoglobinuria (Shaw, 1951); and there have been suggestions that disorders of the blood may result in a definite predisposition to Salmonella infection (Storey, 1958). Similarly, among animals, anaemia may be a definite symptom associated with Salmonella infection and this is particularly noticeable in certain cases of fowl typhoid. Although toxaemia resulting from severe infection with Salmonella may be manifest by a variety of symptoms, experimental evidence during recent years suggests that a direct reaction between the infecting organism and the red blood cell may constitute a significant feature in the development of clinical infection.

The Control of Infection

Chemotherapy

Until some 20 years ago, chemotherapy as a means of controlling bacterial diseases of man and animals formed only a minor weapon in the armoury of control methods. From increasing knowledge of metabolic requirements for bacterial growth and observations on antagonisms between micro-organisms, a new concept for treatment of disease developed. Sulphonamide preparations were overshadowed by the introduction of penicillin; and there soon followed streptomycin and a number of other substances, notably the tetracyclines and chloramphenicol, which are active against a wide range of bacteria. Intensive search continues for other and more effective substances which may not have the disadvantages and limitations now associated with some of the drugs in use. It is not the purpose of this paper to discuss the wealth of literature available on antibacterial substances but to emphasise only those features which have recently become apparent from the use of antibacterial substances for the control of salmonellosis, and the relationship of chemotherapy to other preventive measures.

There are two aspects of chemotherapy which are of particular significance for the successful control of bacterial diseases; namely, the development of specific antibacterial immunity in the host and the adaptability of an organism to its environment. The earlier concept that successful chemotherapy should depend upon the total removal of the causal organism from an infected host may have to be modified in certain circumstances depending upon the relationship between the host and the particular organism concerned. It has been customary to refer to different groups of bacteria as being pathogenic or non-pathogenic. This clear-cut classification is difficult to apply to all members of the Enterobacteriaceae. Shigella and Salmonella are recognised pathogens but Escherichia, Proteus and paracolon bacilli, although associated on an increasing scale with abnormal conditions in the host, are, nevertheless, found as intestinal inhabitants of the digestive tracts of healthy individuals. Salmonella cannot be considered as normal inhabitants of the healthy animal and the purpose of chemotherapeutic treatment of salmonellosis may be the total removal of these organisms from the host. At the same time, some of the antibacterial substances now in use have a wide spectrum of activity and may alter the normal bacterial flora of the intestine.

On first consideration the prompt treatment of salmonellosis with adequate dosage of an antibacterial agent would appear to be the most satisfactory method, as this is likely to lead to the removal of the majority, and sometimes all of the infecting organisms. In the latter circumstance, the life of the individual would be preserved but its experience would have left it as susceptible to subsequent infection as it had been beforehand, since there would have been little or no opportunity for bacterial immunity to have developed. In the former case, there would be a risk of clinical infection developing from residual organisms remaining in the host after treatment has been terminated. In typhoid fever, for example, relapses following the withdrawal of chloramphenicol treatment result from the multiplication of surviving bacilli (Keifer & Wernstein, 1954). In animals, however, the risks may not be only from proliferation of surviving organisms, but particularly from subsequent

re-infection derived from other members of the herd or flock promoted by unhygienic conditions, and also from extraneous sources, especially with ubiquitous organisms like *S. typhi-murium*. There are several examples in veterinary literature of the recrudescence of clinical infection following the use and withdrawal of antibacterial substances; and there is, at present, no such substance which is bactericidal against Salmonella under all conditions of animal infections.

The greatest benefit from chemotherapeutic treatment cannot be obtained without the establishment of immunity in the host to the particular organism. As Knox (1958) emphasised, drugs should be used to reinforce the defence mechanisms of the body, and it is only by a combination of the two that a lasting and reliable effect can be obtained. Previous discussion on the development of disease (*vide supra*) indicated that a solid immunity will only be developed and maintained so long as the immunising bacteria remain in the host. If, therefore, drugs were used in bactericidal concentrations the total removal of the infecting bacteria would result in the termination of the development of immunity. Alternatively, the employment of drugs in dosages which permit the survival of a few of the infecting organisms would allow the development of immunity at the risk of the host becoming a carrier and a focus for future infection of susceptible in-contact animals. Moreover, there is no substantial evidence that Salmonella surviving in a host after chemotherapeutic treatment are potentially less virulent than they were before treatment was commenced. The obvious beneficial results derived from combined chemotherapy and immunisation deserve further investigation, particularly from the point of view of practical application to the control of animal diseases. At the present time, fundamental information on both these aspects does not enable them to be combined in a rational and reliable form of disease control. This must await further research into the adaptation of the causal organism to its environment in the treated host and the effect of this adaptation on bacterial virulence.

Immunity

Many attempts to control salmonellosis in animals by the use of vaccines have been made. For reasons of safety, earlier trials were confined to the use of killed bacterial suspensions; and in 1928 Ibraham and Schütze noted the improved immunogenic properties of a vaccine prepared from a smooth strain of *S. typhi-murium* compared with the use of a rough strain. The immunity derived from a killed smooth strain is of short duration and does not protect mice against repeated and heavy infection (Topley, 1929; Greenwood, Topley & Wilson, 1931a, b). The results of these early experiments in mice have been confirmed by others who have employed killed vaccines in the control of salmonellosis among farm animals, and it is noticeable that reports of beneficial results have frequently been associated with the use of killed vaccines in animals in which the risks of clinical infections occurred within a limited time after immunisation. Thus, some success has been attributed to the use of killed vaccines for the control of abortion in sheep caused by *S. abortus ovis* (Suhaci & Isopescu, 1937; Mura, 1949) and abortion in mares associated with *S. abortus equi* (De Léon & Peluffo, 1946; Monteverde & Garbers, 1949). In circumstances where there is a known risk of fatal infection developing among young animals, mortality may be reduced by vaccination of young calves (Gribanov, 1937; Guerrero, 1943; Henning, 1953) and piglets (Schofield, 1944). However, results from this method of control are not always successful and the low grade of immunity which develops may be insufficient to be of marked benefit to animals exposed to repeated and heavy infection. In a disease like fowl typhoid, in which susceptible birds may be exposed to infection over relatively long periods of time, the use of a killed vaccine is of very limited value.

For reasons of safety the use of living organisms as immunising agents has seldom been employed although it is known that the immunity which develops is of a higher grade (Iwahata, 1935; Ushiba *et al.* 1954; Toba, 1954), and promising results have been obtained from recent trials with a living vaccine prepared from a rough strain of *S. gallinarum* (Smith, 1956a, b; Harbourne, 1957). All the experimental evidence in different species of animals indicates that a solid immunity develops from the adaptation of living bacteria to their environment in the host and from the response of the tissue cells to these adapted organisms. It is from a knowledge of these *in vivo* reactions that an explanation for the development of infection and immunity must be sought.

The advantages of the agglutination test for the control of salmonellosis depend upon not only the reliable interpretation of the test but also on adequate measures to prevent the introduction of infection into the herd or flock. The test is of great value for the control of Pullorum disease for which its success can be attributed to the host specificity of the causal organism together with practical methods for preventing the spread of infection. Similarly, fowl typhoid can be successfully controlled provided the agglutination test is supplemented by strict measures to prevent the introduction and dissemination of infection. The agglutination test applied to the control of infections with motile Salmonella can also be helpful if the results of the test are based on normal agglutinin levels of animals in the particular area concerned (Lovell, 1932, 1934). The interpretation of the test is made more difficult, however, because of fluctuations in these normal titres. For example, the majority of healthy horses possess 0 agglutinin titres against *S. abortus equi* varying from 1:20 to 1:300; whereas those for *S. abortus ovis* in sheep, *S. dublin* in cattle and *S. choleraesuis* in pigs are usually in the range of 1:10 to 1:40. In many instances, interpretation of the results is facilitated by the knowledge that infected animals will develop high agglutinin titres against H antigens, and it is an advantage to test serum samples for agglutinins against both H (phase I) and 0 antigens.

Sieburth (1957) has examined the reliability of the haemagglutination test for diagnostic purposes, using

sensitised erythrocytes as the antigen. He concluded that the test might be applicable on a flock basis to the diagnosis of infection with *S. typhi-murium*. However, the high degree of sensitivity shown by the haemagglutination test and the non-specificity of some Salmonella antigens may increase the difficulty of interpreting the results of this test without previous knowledge of normal flock and herd haemagglutination titres.

The agglutinin titre is more an indication of the rate of multiplication of the organism in the host than the development of specific resistance to infection. During the early stages of acute disease agglutinins may not be detectable in significant concentrations, but thereafter, the titre may rise to a high level in response to increasing quantities of antigen resulting from rapid multiplication of the infecting organisms in the tissues. Death of the host may occur suddenly, irrespective of the level of the agglutinin titre. Carrier animals, in which the rate of multiplication of Salmonella is low, will have correspondingly low agglutinin titres, although these animals may have developed strong resistance to clinical infection. Bearing in mind these features of agglutinin production in relation both to the development of infection, to the significance of normal agglutinin levels and to the epidemiology of the disease, the agglutination test is of value in controlling salmonellosis provided that it is used in conjunction with hygienic measures to prevent reinfection occurring.

Conclusions

An attempt has been made to discuss salmonellosis in animals in the light of recent research and to see in which direction current information could most profitably lead future investigations. At the present time, such a discussion poses more questions than it answers and emphasises the absence of knowledge on the pathogenesis of disease. It is recognised that practically all animal species which have been examined are susceptible to either clinical or subclinical infections. The susceptibility of a particular species may be altered by various conditions, including age, immunity, management, nutrition and concurrent infections with other micro-organisms. Infection may remain localised, or it may become generalised and lead either to death of the host or to a carrier state. The longevity of this carrier state may last for weeks or years, according to the animal species and the serotype concerned. It is noteworthy that the carrier state is more usual and of longer duration in infections with such host-specific serotypes as *S. pullorum*, *S. abortus ovis* and *S. abortus equi*, which have adapted themselves to poultry, sheep and horses, respectively. An explanation in biochemical terms of this relative host specificity would provide some essential information on the reasons for the development of the carrier state. The various symptoms and pathological changes associated with salmonellosis are the responses of the host to infection, but little is known of the chemical pathology of the reactions between the bacteria and the host's tissues. A knowledge of these fundamental problems cannot be solved without studying bacteria in relation to living tissues instead of inert media. In the field of Salmonella, two aspects of research which would advance our knowledge of epidemiology and control measures are firstly, the biochemistry of the adaptation of virulent strains to host tissues; and secondly, a continuation of research into the physiology and pathology of the toxic properties of Salmonella. In the words of Dubos (1954): "An understanding of pathogenesis demands that the phenomena of growth and toxicity be observed under the highly specialised environment characteristic of each host, and of each phase of the infection."

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THE SPEAKER'S INTRODUCTION

Dr. A. Buxton, in introducing his paper, said it seemed better to keep away from the many aspects of the subject in which specialisation had occurred and on which there was an immense amount of recently published literature, and to try to pick out the salient features of the condition as it affected various species of animals under field conditions.

He stated in his paper that some 350 serotypes were recognised but he thought that he would have been more accurate had he suggested the figure of 400 serotypes. This large number was the result of widespread detailed serological examination, together with the employment of more refined media, which enabled the cultivation of very few Salmonella present in relatively large amounts of tissue.

Among various species of animals there was a certain amount of host specificity among Salmonella serotypes; and in addition there was *S. typhimurium*, a ubiquitous organism which was potentially pathogenic to animals and man, alike. From the veterinary point of view the most important organisms in this large genus were these relatively few host specific ones and *S. typhimurium*. The development of techniques for bacteriophage typing sometimes enabled sources of infection to be traced and this was of particular significance when investigating outbreaks of disease in animals and man.

It was important to be able to diagnose, as soon as possible, Salmonella infection in animals. In many cases, symptoms of disease were not sufficient and one had to rely for a definite diagnosis on bacteriological examinations. A rapid diagnosis was essential so that practical measures could be started without delay in controlling the infection. In the first instance the serotype involved was not of primary importance, since with few exceptions methods of control and prevention were equally applicable to various animal species and to different serotypes.

What were the most important methods for controlling and preventing salmonellosis in animals? Veterinary surgeons had to deal with a variety of animal species kept under different conditions. Basically, however, there were three ways of control and prevention applicable to salmonellosis in animals. Firstly, there were available a number of antibacterial agents which although capable of reducing mortality left some infected animals as carriers. Secondly, there were serological methods, especially modifications of the agglutination test, which were of great value for identifying infection in sub-clinically infected animals, provided that account was taken of normal herd and flock agglutinin levels in interpreting the results of the tests. Thirdly, there were immunological methods. The use of killed bacterial suspensions as immunising agents had not been very successful, but recent work on the employment of attenuated or rough strains of Salmonella had revealed their possible value in the control of these animal infections.

In recent years, research on salmonellosis in man and animals had been directed to the study of the pathogenesis of infection. More especially, attention has been given to the relationship between the liberation of bacterial polysaccharides in the body, consequent upon generalised infection, and the actual cause of death of the host. Recent research in the U.S.A. had shown that in mice infected with *S. typhimurium* there was a critical bacterial population which proved lethal. Similar experimental results had been obtained with rabbits, which demonstrated the lethal effects of bacterial polysaccharides. The problem which was now the purpose of many investigations was the effect which the liberation of bacterial polysaccharides had on the metabolism of the host. In this connexion, the possible significance of the *in vivo* adsorption of bacterial polysaccharides on to the surfaces of circulating erythrocytes was being studied, particularly in relation to disorders of the blood associated with salmonellosis in animals and man.

The Opener

Mr. H. I. Field, in opening the discussion, said that in 1949 Dr. Buxton and he had given a paper on this subject to the 14th International Veterinary Congress in London. Since then the related problems of Salmonella infections in livestock and in man had been given a great deal of attention in most parts of the world. As Dr. Buxton had said, certain aspects of the subject had been widely studied, while others were investigated less thoroughly.

His contribution to the discussion, as befitted one whose main concern was with the investigation and control of animal diseases, dealt with the more practical aspects of Salmonella infections in farm livestock. Much of what he would say served to emphasise some of the points made by Dr. Buxton in the paper.

To those who qualified many years previously it might be disturbing to learn that bacteriologists now recognised some 350 different Salmonella serotypes, all of which were regarded as being, at least potentially, pathogenic for animals or man, or both. Furthermore, new serotypes were being recognised frequently. Yet from an animal health point of view the position had not changed materially since the days when a few types were held responsible for all the Salmonella infections in farm livestock. Those types were still, in fact, the main causes of clinical infection in animals. The simplest way to make that clear was by giving some figures as they referred to the different kinds of livestock with which they were concerned.

To start with poultry, in a recent report Blaxland and his colleagues gave a detailed account of the incidence of avian salmonellosis in England and Wales based on the bacteriological examinations carried out in the poultry diagnosis department of the Central Veterinary Laboratory at Weybridge during the years 1948 to 1956 inclusive. During that period 27 different Salmonella serotypes, plus a few untyped strains, were isolated from 3,541 batches of chicks or from individual adult birds. But 88 per cent. of the total isolations were accounted for by 3 types, *S. pullorum* being cultured from 54 per cent., *S. gallinarum* from 14 per cent. and *S. typhimurium* from 20 per cent.

Most of the isolations of the other 24 serotypes were from individual birds, often from cultures of the intestinal contents, and seldom was there any evidence of epidemic disease. Similar findings were reported from other diagnostic laboratories. For example, during the 12-month period ending in May, 1958, of the 750 Salmonellae isolated from adult fowls or batches of chicks in the Ministry's veterinary investigation centres, 628 (*i.e.* 84 per cent.) were either *S. gallinarum* or *S. pullorum,* and 52 (7 per cent.) *S. typhimurium.* Thus those 3 types accounted for over 90 per cent. of the total isolations. It was evident from such findings that although poultry acted as reservoirs for a large number of Salmonella serotypes, the greatest loss to the poultry industry in the country was due to infection with three organisms, the host-specific types *pullorum* and *gallinarum* and *S. typhimurium.*

The position with other species of farm livestock was much the same. Of the 7 serotypes isolated in veterinary investigation centres from 120 positive cattle specimens during the 12 months ending in May of the present year, 2 organisms, *S. dublin* and *S. typhimurium,* acounted for 95.7 per cent. of the total isolations. During the same period four serotypes were isolated from pigs, but 66 out of 73 isolations (*i.e.* 90 per cent.) proved to be *S. cholera suis* and 5 (8.2 per cent.) *S. typhimurium.* The same general trend held good in sheep, for out of 65 Salmonella-positive specimens, 58 (89.2 per cent.) were *S. abortus ovis.* Those figures confirmed Dr. Buxton's statement that the problem of clinical infections in food animals was associated with *S. typhimurium* and the relatively few host-specific serotypes, *i.e. pullorum* and *gallinarum* in poultry, *dublin* in cattle, *cholera suis* in pigs, *abortus ovis* in sheep and probably *abortus equi* in horses.

Organisms of the Salmonella group which were host-specific seemed in large measure to have lost their ability to invade, and cause disease in other hosts; whereas other serotypes, which had no host specificity, might be capable of invading and causing disease in a variety of animals, including man. Therefore, it was found that *S. typhimurium,* which probably had a wider range of hosts than any other type of Salmonella, was fully capable of causing disease in them all. That was very important from a public health point of view, for infection with *S. typhimurium* was the most common cause of outbreaks of food poisoning in man, whereas the host-specific types which caused most of the clinical disease in livestock were relatively of little public health significance. But many of the other serotypes did not appear to have the same degree of pathogenicity as *S. typhimurium.*

It was known that the various species of farm livestock acted as hosts to a large number of the other serotypes and one could only speculate as to the degree of pathogenicity which they were likely to achieve for livestock, although there was no evidence at present that the incidence of clinical disease due to infection with them was increasing. Their occurrence in the animal, however, posed a problem to those concerned in food inspection and public health. Most of those serotypes were harboured in mesenteric glands and occasionally elsewhere, without causing clinical disease in the host. But products of animal origin which contained those types were nevertheless potential sources of infection to the human population. There were, therefore, two separate and distinct problems, that of the Salmonella types which were clinically important in livestock and that of the serotypes which did not ordinarily cause clinical disease but which were potentially dangerous to humans. The two aspects probably needed a different approach, for while it might be possible to control these types causing clinical disease, that in itself would not completely safeguard the human population. It would nevertheless go some way towards it, in view of the public health importance of *S. typhimurium.* It must be remembered, however, that that organism occurred in hosts other than the food animals, notably in rodents, so that its control in farm livestock still left an important reservoir of potential infection.

They knew a great deal about the natural histories of the more common Salmonella infections of livestock, and much could be done to reduce the losses which they caused.

The incidence of B.W.D. caused by *S. pullorum* had been markedly reduced in England and Wales during the last 20 years by a voluntary scheme of blood testing breeding flocks and the elimination of reactors. The percentage of flocks within the scheme found to contain one or more reactors fell progressively from 39 in 1939 to 9 in 1956. That reduction was reflected in the number of outbreaks of B.W.D., for whereas in 1939 the incidence of infected batches of chicks among those examined in the poultry diagnosis department at Weybridge was 24.6 per cent., by 1956 it had fallen to 3 per cent. Intensification of the blood testing policy might, therefore, result in the eradication of both B.W.D. and fowl typhoid.

It was generally accepted that, where practicable, eradication of a disease was preferable to control by immunisation or therapeutic means and that should clearly be the aim with B.W.D. and fowl typhoid. Until some scheme for complete eradication was evolved, however, vaccination as a preventative and treatment with drugs to reduce losses in outbreaks of fowl typhoid had a place in general control measures In the field of immunisation the work of Williams Smith in the laboratory and Harbourne in the field suggested that a live vaccine prepared from a rough strain of *S. gallinarum* gave a satisfactory degree of protection, while treatment of fowl typhoid outbreaks with furazolidone had also been shown to reduce losses, when combined with hygienic control measures.

The blood test for the detection of carriers of *S. typhimurium* was less reliable than the comparable test for infection with *S. pullorum/gallinarum,* largely because antibody level was liable to fluctuate considerably. The development of a more specific test would be generally welcomed and for that reason it was particularly interesting to learn from the paper that the possibilities of using the haemagglutination test were being studied.

Turning to cattle, the problem was mainly one of *S. dublin* infection and, to a lesser extent, *S. typhimurium,* the relative incidence in England and Wales of the one to the other in clinical cases, both in adult cattle and in calves, being in the ratio of 4:1. The clinical effects of infection with either organism were much the same. In calves infection often reached epidemic proportions, whereas in adult cattle, clinical disease was more often than not confined to an individual cow. Field evidence showed fairly conclusively that many of those cases in adults were the result of the stimulation of latent infection by some stress factor. Calves recovering from clinical infection seldom remained carriers, whereas recovered adult cattle continued to harbour the organism and excrete it more or less regularly in the faeces. Those carriers can be readily detected by blood test or faecal culture; preferably by the use of both methods.

Various means of control had been tried in different parts of the world. The disease had a local distribution, its incidence being higher in some areas than in others. In Germany it was at one time a scheduled disease; and in those areas in which it was endemic cultural and serological tests were carried out in herds to detect active carriers. It was claimed that the elimination of carriers resulted in a marked decrease in the incidence of clinical disease. Successful results had been claimed in preventing outbreaks in calves by vaccination of the dams, resulting in the transfer of a passive immunity to the offspring through the colostrum, or by vaccination of calves early in life.

A variety of therapeutic agents were used in the treatment of clinical cases, both in adults and in calves and there seemed little doubt that a clinical response would be obtained. There was, however, the attendant danger that

recovered animals retained the carrier state, thereby exposing in-contact stock to a greater risk of infection. An example of that was shown in a report by Schaaf, who treated 25 clinical cases of *S. dublin* infection in adult cattle with chloramphenicol; 23 recovered after one or more courses of treatment, but of the 18 convalescents subsequently examined all but one continued to excrete the organism in the faeces. Such carriers spread infection to other adult cows giving rise to clinical, or more commonly, latent infection. Carriers also transmitted infection to their calves. Further, the faeces of active carriers contaminated pastures, water supplies and farm buildings.

Epidemiological studies showed conclusively that when active carriers were allowed to remain in herds, spread of infection occurred sooner or later; but experience showed how difficult it was to persuade an owner voluntarily to remove an otherwise healthy carrier from his herd.

Paratyphoid in pigs, due to infection with *S. cholera suis*, was an example of a disease in which the use of a therapeutic agent as a prophylactic was probably the best method of control known at present. The highest incidence of clinical disease occurred in pigs between two and four months of age and the addition of nitrofurazone as a prophylactic to the diet of susceptible pigs in that age group had much to commend it.

Abortion of mares and joint-ill in foals, associated with *S. abortus equi* infection, were well known in most parts of the world. Outbreaks of abortion might occur suddenly in enzootic form among brood mares and might cease with equal rapidity. The problem had become less important in this country with the decline in the equine population and there was little or no evidence to show its present incidence.

S. abortus ovis infection was a recognised cause of abortion in many sheep-rearing areas of the world. In this country it was localised in its incidence—in England being confined to one area in the South West. Despite the fact that that type of abortion in sheep had been recognised for many years, there was still much they needed to know about its natural history. Recent work suggests that infected rams might play an important part in transmitting infection to ewes. The use of a vaccine as a means of prevention might well be re-examined in those areas in which it occurred, in view of the success which had been claimed following its use elsewhere.

Outbreaks of acute gastroenteritis, associated with *S. typhimurium* infection, were reported from time to time both in horses and in sheep, usually following some stress It was a reasonable assumption that they originated in the stimulation of latent infection in one or more carrier animals and that the possibility of extraneous sources of infection could generally be disregarded.

Mr. Field closed his contribution by emphasising the point made by Dr. Buxton in the paper that there were wide gaps in their knowledge of the more fundamental aspects of Salmonella infections. That the author personally recognised that fact was shown by his continued interest in such problems. More workers of a like mind in our veterinary schools and research institutes were needed if those gaps were to be filled. He thanked Dr. Buxton for a most interesting and stimulating paper.

The General Discussion

Dr. D. Luke (Stormont, Belfast): "At the outset I should like to thank Dr. Buxton for his refreshing approach to the problem of salmonellosis in animals. He has stressed wherein lie the main hazards to the health of our animals but there is one aspect of the problem of salmonellosis in general to which he has not referred, *viz.*, the introduction into the U.K. of a variety of serotypes in feeding-stuffs, mainly fish meal. A survey of this problem has recently been completed in Northern Ireland and it has been found that up to about 10 different types of Salmonellae can be isolated from samples of imported fish meal. None of the types found have been reported in Northern Ireland before. Most of the contaminated feeding-stuff is used for the pig and poultry industry and of the varieties found in the feeding-stuff, only 2 types, *S. infantes* and *S. ovis*, are regularly found in bacon and eggs. So far we have not associated any of these types with actual disease in either pigs or poultry, but all the types recorded have been associated from time to time with disease in human beings.

"From examinations of animal protein carried out elsewhere a similar Salmonellae position has been revealed. Not all the types found in these surveys have been non-pathogenic for domestic animals, and *S. typhimurium* has been recorded more than once. It seems highly undesirable that our animal health should be threatened in this way and I should like to have Dr. Buxton's observations on this aspect of the problem."

Dr. A. W. Stableforth (Weybridge): "I should like to refer to the Public Health importance of salmonellosis, which was recently the major subject of a report to the W.H.O./F.A.O. Expert Committee on Zoonoses at Stockholm. In Great Britain Salmonellae were responsible for more food poisoning incidents than all other organisms combined; many more were recorded than for some other countries, *e.g.* the U.S.A., but this is probably due to a more effective reporting system. In this country reports are exchanged monthly between the Public Health Laboratory Service and the Veterinary Laboratory Service.

"The main sources of infection are meat, mostly 'made-up' meat products derived from pig meat in some countries and beef in others, eggs (especially duck eggs) and egg products, and less often milk and milk products.

"Effective methods of detection and control are available, and salmonellosis is a subject in which co-operation of the medical and veterinary professions is of the greatest value."

The Reply

Dr. Buxton, in reply, said that it was true that in recent years there had been found a relatively high incidence of Salmonella in fertilizers, fish meals and so on. The incidences were variable but particularly high in some preparations of fish meals.

Much of the discussion had dealt with public health and this aspect had been omitted from the paper because later at this Congress it would be discussed in more detail. It was difficult to put the subject in the right perspective because at the present time we had too little evidence on the extent of cross-infection from animals to man and *vice versa*. *S. typhimurium* was the most important Salmonella associated with the public health aspects of salmonellosis in animals. One piece of work which was of great value in this connexion was the phage typing of strains of *S. typhimurium*. It was now beginning to show that some of the phage patterns of animal strains of this organism were distinct from those of human strains. The continued application of phage typing both to outbreaks and sporadic cases of human food poisoning would help to provide essential scientific data. Until this information was known, an accurate assessment of the importance of animals and animal products as sources of human infections could not be made.

In recent years there had been a marked increase in the known incidence of *S. typhimurium* infection in man in this country. Potential sources of infection were preparations of meat and eggs, some of which may be imported. In addition, we still had too little information on the changing incidences of Salmonella in domestic animals, and only by the closest liaison between veterinary and medical laboratories could we hope to tackle this problem.

The control of *S. typhimurium* infection in turkeys was still a problem in some outbreaks, but the use of the tube agglutination test and of a modified rapid agglutination test were of value.

On many points concerned with the control of Salmonella it was not possible to give a definite answer. One could only sum up by saying that this was a large group of organisms which were capable of existing in animals and man without necessarily causing any clinical symptoms. Broadly speaking, the agglutination test was a test which gave some idea of the rate of multiplication of the organism in the host, and the carrier animal would usually give a low titre. Frequently, carcases infected with Salmonella appeared normal at the time of slaughter and the presence of infection could only be confirmed by bacteriological examination. This examination might be made more difficult in those cases where the animal had been previously treated with antibiotics because of the slow growth rate of Salmonella isolated from these carcases. The prevention and control of salmonellosis in animals would remain a difficult problem until more was known of the relationship between Salmonella and the infected host.

The Clinical Aspect of Nervous Disease in the Dog

BY

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SUMMARY.—Some nervous diseases as seen in general practice are presented. Treatments with sedatives and vitamin B group, as well as tonics, are suggested.

THE paper here presented is essentially that of a veterinary surgeon in general practice with no specialised knowledge of neurology. It is presented on two counts: first, to enable those associated with neurological research to appreciate the practitioner's difficulties, and secondly, to show the present trends of diagnosis and treatment to anyone not primarily connected with small-animal work.

I have dealt with 4 groups of nervous diseases in their order of importance in our individual practice. They are as follows:—

(1) The nervous signs of uraemia, *i.e.* uraemic convulsions and paresis.

(2) The nervous effects of the distemper-hard pad group of viruses.

(3) Paralysis and partial paralysis of the hind limbs.

(4) Brief observations on idiopathic epileptic fits, hysteria, nerve trauma, eclampsia, and nervous disorders following toxins and poisons.

It is worthy of note that, not many years ago, the list would easily have been led by the effects of the distemper and hard pad viruses.

It is important not to be lulled into a sense of false security by the low incidence of such cases. Vaccination plays an important part in producing a barrier against these diseases, but it would be unwise to regard this as being the complete answer should a new high incidence occur.

Uraemia

Uraemia is defined as an accumulation in the blood of the waste products of body catabolism due to a direct result of kidney damage, and a consequent inability of this organ to eliminate these products.

Perhaps I may be seeing more of this condition than some readers, but in a large city uraemia is frequent owing to the enormous increase in chronic interstitial nephritis. The main factor responsible for its increase is infection with *Leptospira canicola*, and in the city this is becoming enzootic. Experiments which were carried out on a random selection of apparently healthy animals showed a remarkably high *L. canicola* agglutination in a large percentage of those animals from 3 months upwards.

Generally speaking, one cannot correlate the level of the blood urea with the onset of these signs. However, it is true to say they do occur more in cases showing a high reading, *e.g.* 220 mg. plus; but a dog showing a blood urea level of 70 mg. can quite easily show nervous symptoms. It is important to realise that blood urea can only be regarded as a tracer to estimate kidney damage, and although it is a first-class guide, actually the accumulation of other toxic factors brings about a state of "uraemia."

The Nervous Signs of Uraemia

The general nervous symptoms are shown by a characteristic shivering and twitching of muscle groups, particularly in the temporal area. In all probability this is caused by an upset calcium blood level affecting the neuro-muscular nerve junctions.

Contrary to most published reports, we find that a degree of paresis is a common factor, so much so that we carry out a blood urea estimation on all paresis cases as a means of differential diagnosis. The degree of paresis varies from complete paraplegia to cases showing a mild ataxia on walking.

The ultimate nervous symptoms are those of uraemic convulsions, coma, and death.

Diagnosis

The clinical picture is one of gradual ill-health, fading condition, and general debility shown by loss of weight, foetor oris, pallor of the mucous membranes, and loss of coat hair. More specific symptoms are those of consistent vomiting, excessive thirst, diarrhoea, and a degree of tenseness of the abdomen, accompanied by lumbar pain.

The laboratory picture confirms the diagnosis by blood and urine tests.

Estimation of urea in the blood is made by taking a few c.c. of uncitrated blood and estimating the urea level by means of the Archer and Robbs Urease Nesslerisation method (1925). This test is quite simply carried out and can be easily done by a competent member of the lay staff, the only equipment needed being a small oven, a Lovibond Comparator, and a few pipettes.

A reading of 40 mg. per cent. or over is regarded as positive, 80 to 160 as a double positive, and a reading of 160 to 220 plus as a triple positive. The degree of damage to kidney function varies correspondingly.

From these estimations a very accurate prognosis can be made, when combined with the clinical picture. The urine is tested for the presence of albumin, and the method we use is the nitric acid ring test.

Prevention

Vaccination against *Leptospira canicola* gives an effective means of prophylaxis. In cities, dogs should be injected as early as possible with Canicola vaccine to prevent any damage taking place to the kidneys.

The organism is continually active, and as its habitat is the interstitial cells of the kidney, it is extremely difficult to reach with drugs.

Treatment

Where cases of uraemia occur, damage to the kidney has already taken place and therefore treatment is confined, rather to the prolongation of life, than to the restoration of diseased tissue. Initially, we try to rid the body of as many of the accumulated toxic products as possible, and to this end we find that the use of infusion therapy gives very satisfactory results. The method we use is the injection of 5 per cent. glucose saline at a dosage of 10 c.c. per lb. bodyweight intravenously, given at the approximate rate of 20 c.c. per minute. This is followed by daily doses of Hartmanns solution given at the same rate per lb. bodyweight. Repeated blood urea checks give a guide to the effectiveness of the treatment. We continue treatment until a stable blood urea level is reached. The treatment is described more fully in a paper given to the B.S.A.V.A. congress (Pittaway, 1958).

It is impossible to get a high percentage of recoveries from completely uraemic dogs, but results are quite good enough to be worth attempting. With mild cases the results can be astonishingly good. In most cases we combine infusion treatment with injections of vitamin B intravenously and vitamin C intramuscularly. The diet is restricted to a protein reduced one for a long period, if not indeed for life. Initially, monthly checks on the blood urea are carried out, and thereafter three- to six-monthly testing is advocated. The diet which we use to follow treatment is given below, and is a protein reduced one to lower the urea forming factors. Eliminate from the diet altogether: meat, fish, poultry, eggs, tripe, offal, and cheese. Suggested food which the animal can have is: bread (preferably baked), dog biscuits, hound meal (meatless), green vegetables, root vegetables, cake, sweet biscuits, sugar and sweet things of any description, rice puddings, milk in moderation, and gravy, fish water, oxo, etc.

Nervous After-effects of the Distemper Hard Pad Group Virus

I apologise to virologists for grouping these or any other new subdivision of the viruses into one class, but I feel from the practitioner's point of view that subdivisions of the disease become increasingly difficult to place into any well marked groups, although the classic subdivision by MacIntyre, Trevan and Montgomerie (1948) is the important one histologically.

We must, however, take note of the changing picture of the syndrome of classical English distemper to the hard pad disease of modern times. Although we seldom see hard pads as such, the chief feature to-day is its preponderance of nervous symptoms which have risen from approximately 7 per cent. to close on 90 per cent. in some present outbreaks.

To us, the effects on the animals of the distemper-hard pad complex occur in one of three ways: epileptiform convulsions, chorea, and paralysis. There may be any degree of severity of any one, or of all, these signs together. I think it is true to say that we are getting to the stage where we regard pyrexia as potentially indicative of future encephalitis, just as much as if these dogs had the more classical preliminary symptoms. It may also be worth while mentioning here that many workers feel that the distemper-hard pad complex is often complicated by other conditions, for example leptospirosis and Rubarth's disease (canine virus hepatitis).

Epileptiform Convulsions

These are the most common sequelae to infection, and may occur as a primary symptom, or at any time from one day to months after initial infection. The attack is preceded by markedly congested mucous membranes and injected sclerae. A definite restlessness is noticed, with a tendency to whine. Often a ravenous appetite is present, and not infrequently a complete change of temperament. In some cases this is followed by uncontrolled champing of the jaws. Ultimately, a complete convulsion takes place and this may vary in time and severity—occurring at irregular intervals from minutes to days. Occasionally, cases stop progressing at the jaw-champing stage. Odd cases completely recover from the convulsions, but normally the changes are irreversible and humane destruction must take place.

It is of note that these nervous convulsions are nearly always associated with cases showing diarrhoea. The bacterial picture is included and shows a high incidence of *Bacterium coli* infection.

SECONDARY ORGANISMS ISOLATED FROM ATYPICAL DISTEMPER CASES
TOTAL NUMBER OF CASES 867
CULTURES POSITIVE IN 592 CASES

Organism	Percentage of positive cultures	Total no. of cases	Site of isolation			
			H.B.	Lung	Liver	Gut
E. coli alone	30·9	183	85	148	91	89
E. coli and *B. proteus*	31·4	60	34	47	36	37
E. coli and pasteurella		3	2		2	
E. coli and cocci		99	50	62	45	36
E. coli and pyocyaneus		16	9	13	10	6
E. coli and *B. aerogenes*		8	2	6	6	4
B.H.S. Group A.	9·1	3	1	3		
B.		1	1	1		
C.		5	3	4	2	2
G.		26	11	22	11	2
L.		6	3	4	3	2
M.		2	1	2		
Ungrouped		2	2	2	1	1
B.H.S. and *B. proteus*	18·5	9	8	8	7	
B. proteus alone		17	13	16	9	7
B. proteus and cocci		15	15	15	15	15
Cocci alone		70	26	57	28	11
Paracolon		6	4	3	4	3
T.B.		2		1	1	2
Salmonella enteriditis	74	11	10	11	10	11
S. typhi-murium		30	21	23	25	25
untyped		3	1	2	1	3

Chorea

Contrary to the opinion of many writers, I disagree that chorea disappears after a time. In my view, post-viral chorea is usually a constant entity for life, and although it might improve slightly it seldom completely clears up. The continuous twitching does

not seem to cause the dog any discomfort, but excessive tiredness or excitability seem to aggravate the condition.

Minor degrees of chorea should be subject to research, and I feel the possibility of local neurectomy, or even the location of the site of these peculiar brain lesions might be a welcome discovery to practising veterinary surgeons. Its onset is gradual, and if it progresses to an excessive extent—causing twitching of most of the body muscles—euthanasia is the only course. Tonics and the vitamin B group are a help, but so far there is no specific drug to deal with this condition.

Paralysis

The onset of paralysis like that of chorea is a gradual one. It is met with as the least common of the nervous complications. When it does occur, the degree of damage varies from mild ataxia to complete paralysis, and apart from tonics, I know of no means of controlling its onset. Occasionally, odd dogs recover completely, but the usual outcome is either a staggering dog with incomplete motor function, or a case of complete paralysis, when again euthanasia is the only outcome.

Prophylaxis

There is no doubt that practically all cases of nervous disease of virus origin are found in non-immunised dogs.

Previously, with the Laidlaw-Dunkin methods of prophylaxis, certain dangers were inherent in that virulent virus was used and dogs became infected through the method. With the advent of egg-adapted American virus the threat of infection through vaccination has been removed, and uninhibited immunity is developed. Although pathogenicity has been eliminated, it is still necessary to inject only healthy dogs.

Treatment

This, of course, includes the general treatment of the disease before encephalitis develops. It is always useful to give a full dose of hard pad serum or gamma globulin at a therapeutic level, as these are really the only specific anti-viral agents we have. Often the poor results quoted with the use of this serum and gamma globulin are due to under-dosage. A full dose should be given and this should be repeated in 24 hours. The combined use of serum intravenously and subcutaneously is in our opinion exceptionally useful.

Secondary bacterial infection plays a big part in the final outcome. The organisms commonly involved are often penicillin resistant. Streptomycin and oxytetracycline* and the normal wide-range antibiotics are the most satisfactory. If injection twice daily is difficult, then I feel chloramphenicol†, chlortetracycline,‡ or oxytetracycline by mouth can be substituted. Sulpha drugs are contra-indicated as they may be associated with starting off encephalitis.

Encephalitis may be associated with severe headache, and salicylates may be of great value given at the rate of 10 g. 3 or 4 times daily.

Vitamin B and arsenic tonics are of value to speed convalescence, but if the dog has diarrhoea, dysentery, or gastro-enteritis, food must not be forced on it.

Under no circumstances should the dog be allowed more than a minimal amount of exercise as this brings on nervous symptoms extremely quickly.

Where dehydration is apparent infusion therapy is of great value.

Other Causes of Paralysis of the Hind Limbs

Apart from those already mentioned, the following causes are listed for their value in differential diagnosis:—

(a) Street accidents.
(b) Prolapsed intervertebral discs.
(c) Strokes.
(d) Spinal ossification.
(e) Overdose of barbiturates.
(f) Constipation.
(g) Pyometra.
(h) Tumours.
(i) Certain hereditary factors.

We have here a number of similar conditions varying in degrees from mild ataxia to complete paralysis. In general, the temperature and history of ill-health are the best guide to differentiation.

History of accident is self evident, and radiological examination gives evidence of structural damage. Where it is confirmed the prognosis is good and the faculty for healing from trauma is remarkable.

Prolapsed intervertebral discs occur chiefly in the long-backed breeds and again show a high ratio of recovery when left to rest and given such sedatives as may be required for the relief of pain.

Strokes are very characteristic in that they nearly always show hemiplegia. The recovery is phenomenal in dogs, and given time even some dogs showing marked hemiplegia will often fully recover.

Spinal ossification shows on X-ray, and the slow, insidious onset and rigidity of the spine are quite characteristic.

Overdose with barbiturates usually occurs where the animal is under treatment—giving weakness in the hind limbs.

This reaction can be put to good use in dogs who have formed the habit of carrying a leg after some injury—for example, radial paralysis where function has returned but lameness is still present. Keeping an animal for a week or 10 days in a state of mild staggers helps greatly to force the animal to regain the use of the afflicted limb.

I think all dogs with ataxia should be given a good dose of liquid paraffin to exclude the possibility of constipation.

Cases of pyometra often show weakness in the hind limbs and it is as well to be aware of this when considering a differential diagnosis.

Heavy metal poisons such as lead will induce paralysis of the hind limbs, and can be diagnosed by careful history from the owner.

On rare occasions a hereditary factor has been recorded in the case of St. Bernard dogs (Stockard, 1936).

* Terramycin.
† Chloromycetin.
‡ Aureomycin.

Other Nervous Diseases

Idiopathic epilepsy occurs occasionally in dogs and is usually difficult to diagnose. Low calcium, parasites in the gut, and larvae migrating into the nervous tissue are some of the explanations. Various treatments have been suggested, but sedation is the only one which is completely effective. Unfortunately, once the use of drugs like Primidone is left off the condition usually returns. Hysteria has fallen completely from the very large number of cases to the very occasional one. This is mainly due to the discoveries of Mellanby in connexion with agenised flour, and the correction of the dietary constituents by dog food manufacturers.

Eclampsia does not present much difficulty in diagnosis because of its association with motherhood. Calcium borogluconate intravenously, combined with pethidine, and the removal of the puppies gives an effective result.

Poisons and Toxins

The nerve damage caused by such neurotropic toxins as tetanus continues to be completely unresponsive to treatment, and in the rare cases where it occurs in dogs it is usually fatal. Cases of nerve damage by such poisons as strychnine sometimes recover if the dose has been small. Anaesthetising the animal with pentobarbitone sodium combined with chlorpromazine relieves the spasms both in tetanus and strychnine-affected animals.

Acknowledgments.—Many people have helped me prepare this paper, but in particular I would like to extend my thanks to Dr. Montgomerie and Mr. MacIntyre of the Wellcome Foundation for allowing me to use the chart of secondary organisms, and for all the helpful criticism and advice they have given to me.

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THE SPEAKER'S INTRODUCTION

Mr. E. M. Pittaway, in presenting his paper, said that he might perhaps be accused of over-emphasis on the nervous corollaries of chronic interstitial nephritis, but he felt that it was of great importance as its noticeable increase was a constant danger to those in practice. Since the publication of the paper, there had been the usual wave of distemper hard pad infection which was customarily expected following the kennelling of many pets while the owners were away on holiday. He felt very strongly that owners should be categorically advised not to place their animals in the hands of any kennels which would not insist on inoculation before entry.

With regard to the animal being presented in practice, the author believed that the greatest help to the veterinary surgeon was the history which could be obtained from the owner. Routine examination of temperature, pulse, respiration, mucous membranes was, of course, essential, but so far as he was concerned, the question of any change in temperament even a week or two previously or an attack of diarrhoea was of paramount importance. Clinical observation of excessive nervousness on handling uncontrolled shaking or the wild congested look of the eye were again of the greatest importance. Specific nervous examination for lesions was again greatly helped by the history of convulsions, chorea, ungainly gait, or the inability to climb stairs. They helped to localise the condition.

If the damage were cerebral then a change in temperament, convulsion, or excessive restlessness was often an indication. Damage to the cerebellum would show disturbance of muscle tone, trembling, extreme postural abnormalities such as high stepping, and inability to judge distances. Should the vestibular mechanism be damaged, tilt of the head, rolling, and circling would be observed.

Clinically, damage to cranial nerves could be roughly described as that of the first, second, third, fourth, sixth, and would show eye damage either by bumping into things, inequality of the pupils, or an inefficient response of the pupils to light stimulus. The 5th cranial nerve would, if damaged, show hyper or anaesthesia of the face or head or by upset in mastication, deviation of the jaw or paralysis and atrophy of the masseter or temporal muscles. The 7th showed facial paralysis. The 8th showed upset to hearing or balance, the 9th lack of sensation in the pharynx or anaesthesia of the tongue. The 10th showed laryngeal paralysis, slowed pulse, or respiratory or digestive upset, the 11th showed neck or muscle weakness, and the 12th protrusion of the tongue. Lastly, observation of the dog's reflexes could be of the greatest use in determination of any spinal injury or lesion. Obviously pain or lack of it were the best indications. Excessive reflex was shown above the lesion and reduced below it. The neck muscles and skin were supplied by cervical 3rd, 4th, 5th.

Check of the pinch reflex on the forelegs and also the extensor thrust and, of course, lack of sensation, indicated that the site of the damage would be in the cervical 6th, 7th, 8th, or thoracic 1st and 2nd, or extensions of those into the nerves of the brachial plexus.

The chest itself and the muscles of the lower ventral and lateral abdomen were supplied by the thoracic nerves and the skin prick reflex was indicative. Again, loss of pinch reflex and extensor thrust and also the loss of the patellar knee jerk indicated damage to L 4th, 5th, 6th, 7th, S 1st, 2nd, 3rd, L 4th, 5th, 6th, 7th, S 1st, and L 4th, 5th, 6th, respectively.

No one test was indicative, but the answers to localisation of nerve damage must be based on careful history, clinical observations, laboratory tests, radiography, and the specific tests which were described. A combination of all those would often greatly help to establish an accurate diagnosis and thereby make treatment and prognosis more effective.

The Opener

Mr. W. T. Harrow, in opening the discussion, said his first impression on reading Mr. Pittaway's paper was how successful he had been in achieving his two declared objectives—to enable research workers to appreciate the practitioner's difficulties, and to outline present trends of diagnosis and treatment to anyone not primarily connected with small animals.

As to the first, they were all, he thought, research workers included, in favour of keeping the research workers' feet on the ground. It was all too easy to convert a small back room into an ivory tower, and the good research worker appreciated that.

Mr. Pittaway's showing of present trends of diagnosis and treatment would interest everyone, and not only those "not primarily connected with small-animal work," as he put it.

The order of importance of the various nervous diseases in Mr. Pittaway's experience was most striking, particularly

to those who had not been regularly engaged in small-animal practice during the last 10 or 15 years.

The reversal of the positions of the distemper hard pad virus group and of chronic interstitial nephritis was indeed a tribute to the effectiveness of present methods of vaccination. It was also a tribute to the propaganda methods of the veterinary profession and the producers of the vaccines. It would appear to be time now to apply similar methods to the popularising of prophylactic vaccination against leptospirosis.

Mr. Pittaway had dealt adequately with this cause of nervous disorder, and the speaker had nothing to add to what he had said. Nor could he presume to say much on the subject of canine distemper and hard pad except to draw attention to the interesting observation that epileptiform convulsions in this group of diseases were nearly always associated with those cases showing diarrhoea.

"Teething fits" in puppies—and in children—bowel parasites, dietary errors (as distinct from Mellanby's "agene convulsions"), and the diarrhoea of virus diseases all had some degree of enteritis as a common basis. In each case the associated nervous disturbance clears up when the bowel returns to normal. Presumably there was some form of toxaemia present which had the effect of stimulating the "viscero receptors" referred to by Parry (1949).

If he might make a slight digression at that point he would just question, in passing, Mr. Pittaway's repetition of the statement that the sulphonamides may cause encephalitis if used in the treatment of diarrhoea associated with virus infections. In his own experience, admittedly limited, Mr. Harrow had been unable to observe it, and the New Zealand Veterinary Association in fact recommended sulphonamides for this purpose in their recently published handbook (1958). Nervous disorder was not a symptom of sulphonamide poisoning, and interference with normal bowel flora was as great, if not greater, with the broad spectrum antibiotics as it was with the sulphonamides. Most, if not all, of the bacteria listed by Mr. Pittaway were susceptible to the heterocyclic sulphonamides, and these drugs were, in Mr. Harrow's experience, effective and without side-effects.

He would like to discuss and to enlarge briefly on some of the conditions referred to by Mr. Pittaway under the heading of "Other Nervous Diseases." While far less commonly met with than uremic convulsions and the virus disorders they were equally distressing to both owner and patient. They were also in many cases amenable to treatment with some of the more interesting new drugs.

First, epilepsy in the dog. Probably the commonest form of epilepsy in dogs was the grand mal seizure, in which there is a short initial "aura" in which the animal adopts a vacant expression, retracts its head, and begins to champ its jaws. This stage is followed by tonic spastic extension of the head, limbs, and tail, the animal falls on its side, respiration ceases, and all consciousness is lost. This phase usually lasts about half a minute, after which it passes into the chronic phase, during which respiration is resumed and co-ordinated running movements of the limbs occur. Control of the sphincters is lost: there is evacuation of faeces and urine, and saliva drools from the mouth. This phase may last a minute or longer, after which the animal recovers with no apparent recollection of the occurrence.

Grand mal epilepsy was often truly idiopathic. That is to say, there was no evident cause, but it had to be distinguished from the focal or Jacksonian seizure which usually followed some head injury such as depressed fracture of the skull. In this type of case there was a definite initial focal sign, such as the twitching of a limb or muscle group before the onset of the grand mal attack. The muscle group affected was that related to the part of the brain which had been subject to injury, and the animal usually fell on the side on which the lesion was present. This was well illustrated by a case described by Steel and Wyke (1947) in a racing greyhound which banged its head on the door of the starting box at the beginning of a race. The dog finished the race and remained normal for about a month before "fits" occurred. For the next 4 months fits occurred at irregular intervals, sometimes 2 within 24 hours, and sometimes one in 8 days. When in a fit the animal was observed to lie on its right side with its head and eyes turned to the left, and at the beginning of the clonic phase there was twitching of the left leg commencing at the paw and progressing up to the shoulder. Involvement of the trunk muscles was followed by a similar spasm of the left hind leg, after which a general clonic seizure took place. Subsequent examination of the brain showed a small area of necrosis surrounded by a scar in the cortex overlain by an old subpial blood clot in the motor region related to the left foreleg.

Jacksonian seizures were not common but might be met occasionally and presented an interesting problem in diagnosis.

"Petit mal" was considerably more important in man than in animals. In this type of seizure consciousness is disturbed but not lost, so that the subject appears unaware of his immediate surroundings but is not unconscious. Balance is usually retained and the main signs are twitchings of muscle group. The seizure only lasts a few seconds and may be mistaken for chorea.

"Anxiety states" were sometimes seen in which the animal, although it had always been kindly treated, showed extreme apprehension for no apparent reason. "Confusional states" constituted another form of nervous disorder in which a usually docile animal showed an exaggerated response to normal handling and outbursts of rage provoked by apparently harmless situations. Such states had been classified as a form of epilepsy, although no actual seizure occurs. Some of their importance lay in the fact that clients had been lost by dogs developing either of these states in association with one's own premises!

A condition which perhaps cannot be properly described as a nervous disease, but which was an extremely troublesome disorder, was motion or car-sickness. In man it was said to be due to the effect of movement on the semicircular canals or, in other cases, to apprehension. A theory had been advanced that it was due in some mysterious way to static electricity built up while the car was in motion, and judging by the number of cars which one saw with dependent chains, this theory was a popular one. However, in parts of Africa where the handling of a car after a journey could result in really painful shocks, motion sickness was not noticeably commoner than in Britain where car tyres were usually wet enough to prevent static build-up to any detectable degree.

Mr. Harrow had by no means covered all the types of seizure which had been described in the literature, but this was essentially a practical paper and they should not lead the discussion away from practicalities.

Having made his diagnosis the practitioner's next interest was treatment. When he was a student, a dog suffering from nervous disturbance of any kind was given a mixture of potassium bromide and chloral hydrate. If this did not work he was given bigger doses of potassium bromide and chloral hydrate, and then perhaps phenobarbitone. Potassium bromide mixtures were still excellent sedatives if the disorder was mild and transient—as in the type of case which would recover once the underlying cause was cleared up. But in severe cases such high doses had to be given as to render the patient somnolent and to cause inco-ordination of the limbs. Further, the appetite was depressed at a time when it was essential that the plane of nutrition should be kept high. But to keep this discussion in logical order he would like first to refer to the control of the nervous symptoms in the hard pad distemper group of diseases.

Concerning the control of the nervous symptoms of hard pad disease, no mention had been made of the observations of Hodgman and Singleton (1955). These workers suggest the administration of primidone in conjunction with gamma globulin therapy whenever scleral congestion suggests the presence of subclinical encephalitis. Treatment, they emphasise, must begin as early as possible and be continued for long periods, up to 4 or 6 weeks if necessary. Although controlled work on these lines had not been carried out, clinical experience suggested that such treatment materially reduced the incidence and severity of nervous complications in that disease. That had been confirmed by Jaksch of the Vienna Veterinary Academy and others (1956).

The treatment of idiopathic grand mal epilepsy presented a problem suggested by Mr. Pittaway in that the condition often returned when treatment was suspended. The reason

was, of course, simply that because no cause was apparent it could not be removed.

Thus, if the dog was particularly valuable or the owner particularly fond of it one might be faced with prescribing treatment for the rest of its life. He had in fact been treating a Dalmatian dog for the last 7½ years! It followed that drugs used under such circumstances must be entirely free from the side-effects which he had already mentioned. Unless the dog was alert, eating and behaving normally, he was better dead. The Dalmatian referred to was having one severe fit every 4 days despite potassium bromide doses sufficient to cause slight general depression. Primidone was given at the rate of 400 mg. daily and 5 more fits occurred during the next 4 months. The dosage was increased by 200 mg. after each fit until the animal was receiving 1,200 mg. daily. No further fits were seen for a further 5 months, when the dog suffered a painful injury. A slight fit ensued on the following day. The dose was increased to 1,400 mg. for 14 days, then reduced to 1,200 mg. Every few months some crisis—dietary indiscretion, undue excitement, etc., would provoke a mild fit, and it was finally decided to standardise the dose at 1,500 mg. (just over 40 mg. per kg.). The dog had had no more fits since then. It was now 13 years old and in very good general condition.

The drug was not cheap, but the cost of treatment was not more than the price of 10 cigarettes a day. On occasional idiosyncrasy might be met which could be overcome by starting treatment on minute doses and stepping it up over 7 to 10 days.

As Mr. Pittaway said, true canine hysteria was now rare since the importance of agenised wheat gluten had been recognised. Mr. Harrow thought, too, that the public was better educated in canine nutrition, and also that the general improvement in the standard of living had to a great degree been passed on to the dog. The availability of high quality tinned meat diets specially prepared for dogs had undoubtedly improved the position. When it did occur, canine hysteria was readily controlled by primidone.

Turning to the other conditions he had mentioned—the anxiety and confusional states, the excitable nervous and intractable dog, and car-sickness—the ataractics which were proving very effective in their control comprised a most interesting group of new drugs. (The meeting would remember that ataraxy was the indifference aimed at by the Stoics, and this class of compounds had been so named because it produced stoical indifference! They were perhaps better known as "tranquillisers.") There were not less than 18 of these compounds at present on the market in America and Britain under at least 30 trade names. There were 4 main groups of ataractics, classified according to their chemistry:—

1. Rauwolfia alkaloids. These were, of course, of vegetable origin, probably the best known being reserpine. They were used mainly in man, particularly for the treatment of hypertension, but they had also an ataractic action and had been used in the United States for tranquillising "highly emotional and nervous dogs." It had, however, been stated by Haas (1955) that dogs had a species sensitivity and toxic effects could be easily produced. Other workers disagreed with this, but certainly the effective dose on a bodyweight basis was lower than in man. Since other compounds were considerably less toxic there seemed to be little point in using these alkaloids in the dog.

2. The second group comprised the phenothiazine derivatives, of which chlorpromazine and mepazine were perhaps the best known. Chlorpromazine depressed conditioned responses, and antagonised motion sickness and emesis induced by drugs. It depressed abnormal motor activity, including irritability of the myocardium, and produced tranquillity in agitated patients. It potentiated the action of anaesthetics and was widely used for anaesthetic premedication. It lowered blood pressure by producing vasodilatation, and also had an antihistamine action.

Chlorpromazine had the advantage of water solubility which meant that it might be given by injection by any route as well as by the mouth.

Mepazine was similar in action to chlorpromazine and had been used by Lord and Archibald (1957) for allaying nervousness, and as an adjunct to digitalis in heart conditions in the dog. Like chlorpromazine it potentiated the barbiturates and was found to produce a smoother recovery from them. These authors found the drug ineffective in changing the nature of vicious dogs, nor did it have any intrinsic analgesic action. "Complete or nearly complete" suppression of post-distemper chorea for at least 4 months had been claimed by some American workers (Emele *et al.*, 1957), but as this was the result of observations in only 3 dogs further work was obviously required.

3. The third group of ataractics included the benzhydrol derivatives of which benactyzine was the best known in this country. It had a marked potentiating effect on barbiturates and was highly effective in quietening nervous animals. In man it produced loss of sense of responsibility, and in the dog this might manifest itself by the animal becoming disobedient and dirty. For this reason the use of the drug was probably best reserved for dogs kept in kennels.

It had the great advantage of being considerably cheaper than many other drugs of this kind.

4. The fourth group was that of the hydroxypropane or glycerin derivatives, represented by meprobamate.

This group had no effect on the autonomic nervous system and therefore no effect on digestion or bowel action. Also, it had no synergistic action and could be used safely with other drugs. In general this group of drugs was less depressing than the phenothiazine group. It was a potent, long-acting muscle relaxant, although it acted on skeletal muscle only. For this reason, in addition to its use for quietening nervous animals, it was indicated in the relief of muscle spasm, as in so-called rheumatic conditions.

Meprobamate had fewer side-effects than the other ataractics and was probably therefore the safest for prescription for administration by the owner.

Ataractics were useful drugs. They had been called chemical restraining agents. Certainly they avoided the need for much physical restraint and were considerably more humane and pleasant to use.

In conclusion, Mr. Harrow offered his sincere congratulations to Mr. Pittaway on his very sound and practical paper.

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The General Discussion

Mr. J. A. Dall (Torquay): "In the treatment of chronic nephritis a small daily dose of chloramphenical has proved useful. Although fluid therapy is undoubtedly very useful it can only be justified in the acute phase of the complaint, and as soon as possible Vichy water should be used as drinking water. There is great difficulty in getting dogs to drink this.

"I am glad to hear of vitamin C being used as it is often assumed that even the diseased kidney can synthesise vitamin C.

"I would have considered that gravy was worse than meat, containing as it does extracts from the meat. I cannot get dogs to eat the type of diet suggested and I consider that a small amount of meat is essential and not very detrimental.

"I am surprised at the very passing reference to Rubarth's disease as a cause of nervous sequelae. In the acute canine virus hepatitis case nervous symptoms are often severe and, in my opinion, the 'crawler' pup and the 'fading' pup are exhibiting the nervous complication of this disease.

"To the list of other causes of paralysis of the hind limbs, breed incidence might also be added, for example, the paralysis of the old Alsatian.

"Phenobarbitone is one of the most useful drugs in the treatment of nervous disease in the dog."

Mr. S. Jennings (Glasgow): "The essayist has not referred in his paper to the epileptiform fits which are seen in newly weaned puppies. These fits appear to be associated with some bowel irritation. An apparently healthy litter of newly weaned puppies were once observed to have fits one day each week and it was the day following the half day of the man who fed them. On this day a gardener fed them by throwing their usual soft mash on to a pathway covered in small granite chippings. Breeders often refer to 'teething fits' and one wonders if it is possible that fits during the changing of teeth is not due to the passage of sharp, deciduous teeth through the alimentary tract.

"There appears to be no one remedy for motion sickness. My own dog is an extremely bad subject for car journeys and chlorpromazine and other common remedies fail to give any protection."

Miss O. Uvarov (Cobham): "I am interested in all that has been said on the importance of uraemia as one of the causes of nervous diseases. It should, however, be realised that this condition is not a newly discovered disease as has been implied, but that it has been recognised in the early 'thirties'—if not before. It is more important now to record the numerical incidence of nervous disorders associated with uraemia, particularly in relation to the same state originating from viral infections. Can the speaker state over what period of time is there 'an enormous increase in chronic interstitial nephritis'? If so, is this confined to certain cities? There is an impression that nephritis is not as prevalent as formally, and that improved diagnosis, early antibiotic treatment, and the importance of after care of such patients, are all better understood.

"Does the speaker agree with the American findings that in cases of nephritis due to Leptospira, the organism can be reached by streptomycin, which is excreted by the kidneys? In this, the recommendation to the U.S.A. army dogs on the use of streptomycin as prevention of carriers in such cases, is important.

"Dealing with treatment of uraemia—does the speaker ever experience cases of water-logging and oedema when using large volumes of glucose saline? Has he any experience with the use of dextran solutions in the treatment of uraemia?

"I should be interested in further evidence on the importance of vitamin B given intravenously, and that of vitamin C, intramuscularly. The diet recommended for uraemic cases appears somewhat unbalanced. What is the value of Oxo, and is the essayist speaking of real gravy or the ersatz varietv? Does he advocate restriction of water, or even inclusion of barley or mineral waters?

"Despite the amount of work done on canine nephritis, further aspects require more detailed investigation. This should include the effect on the cardiovascular system and the condition of the eyes. In enumerating the effect of damage of the various nerves, does the speaker imply that all these have been encountered in cases of nephritis and uraemia?"

Major J. H. Wilkins (Aldershot): "There is more empiricism in the diagnosis and treatment of nervous disease in dogs than most other canine ailments.

"I would like to ask one question. What is the routine for examination of a dog suffering from nervous disease? I am prompted to ask this since talking to Dr. Carmichael, the Director of Research at the Hospital for Nervous Diseases, Queen Square, who asked me the same question. My answer to him obviously did *not* measure up to his routine!"

The Reply

Mr. E. M. Pittaway, in reply, referred to the use of sulphonamides and said that he had been led into the belief that sulphonamide reaction precipitated nervous troubles. That belief was mainly due to work done by Burroughs Wellcome & Company, although it was only one experiment. By the treatment of some dogs with sulphonamides it was possible to introduce encephalitis, but the experiment apparently was repeated without success.

The reaction of the brain to compression fractures was of interest. Interesting experimental work was done on dogs and reported in the publication *Brain*. Repeated experiments were carried out in the form of blows on a dog's skull, and the amount of blows required, single or repeated, to produce any nervous lesion which was noticeable was surprising. It was interesting to note that in the case of the greyhound the reaction came a month later. A road accident brain lesion might appear at a later date. The only history he had was of one particular dog which had fits. It transpired that the animal had suffered in a road accident 6 months previously. In the author's view there was a tie-up between road accidents and brain damage showing at a later date.

The incidence of leptospirosis was phenomenal. His city was full of leptospirosis, and he always used streptomycin in acute cases.

He had not been able to produce waterlogging except under anaesthesia. He had not used dextran for nephritis, but vitamin C had a certain amount of diuretic value. The author had never experienced any trouble in getting a dog to take to the diet after the first few days in the treatment of nephritis.

He always used bromide in cases of hysteria and found it quite successful. It was doubtful whether Vichy water could be obtained in Coventry.

In his view dogs should be kept as free from protein as was possible. If the urea level stayed low a small quantity of protein was allowed. Flare-ups of old cases happened at Christmas time due to digesting too much meat fed by the owners' over-kindly relatives!

The only objection he had to phenobarbitone was the tendency for it to produce a weakness in the back legs. With primidone that did not occur.

With regard to the question of breed incidence in nervous diseases, there was a certain amount, and if many experimental stations were to change over from using rough Terriers to Poodles, better information would be obtained concerning encephalitis. The same applied in the case of Alsatians and paralysis following viral attacks.

Mr. Wright referred to the prolonged use of Largactil. The author had used it for very long periods without any trouble. The dark ground illumination of urine was useful and was used in acute cases. The author found that the reaction of individual dogs to any form of tranquilliser was varied. It was necessary to start with low levels and work upwards.

He considered that bowel irritation was an important factor in nervous diseases.

As regards routine examination of the dog, in his view it was not as easy to examine a dog for nervous lesions as it was a human being. The human patient could give great assistance by answering questions, whereas in the case of the dog it was necessary to rely on base reflexes and on the eliciting of pain or lack of pain.

Pre-natal Transference of Antibodies

BY

F. W. ROGERS BRAMBELL

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I AM greatly honoured by your invitation to address this Plenary Session of the British Veterinary Association Congress to-day, for I have neither veterinary nor medical qualification. I imagine that the reason you have invited me is that I have the privilege to direct the Agricultural Research Council's Unit of Embryology. The subject that I have chosen to address you upon is the prenatal transference of antibodies. Perhaps I had best begin by reminding you that the adult organism develops immunity in response to experience of an antigen. Hence, the immunological equipment of the adult is only developed gradually in relation to the antigenic environment and the particular hazards of infection to which the animal has been exposed. Indeed, the immune response does not appear for some days after an initial exposure and becomes much more pronounced with repeated exposures. It follows that the young animal cannot equip itself in advance with an active immunity to the hazards it may meet and it does not in fact develop the capacity to produce antibodies, even when exposed to antigenic stimuli, until some considerable time after birth. It may well be that this long delay in the capacity to develop immunity is a positive advantage to the animal, while it is developing in the internal environment of the mother's uterus, for it ensures that it will not react to those maternal antigens which it itself does not possess. Hence, incompatibility diseases, such as haemolytic anaemia, are always the result of the immunological reaction of the mother to the antigens of the offspring and, so far as is known, never *vice versa*. However this may be, the new-born mammal or newly hatched chick would be without immunological protection were it not equipped with the mother's outfit of antibodies.

Young birds and mammals derive their immunity to disease ready-made from the mother by the passive transference of these antibodies from her circulation to theirs. This transference takes place by way of the yolk of the egg in birds. In some mammals, notably the rabbit, the guinea-pig, and man, transference is completed before birth. In some, such as the rat, mouse and dog, some transference occurs before birth and the greater part after birth. In some, including the ruminants and the horse and the pig, it takes place exclusively after birth. Transference before birth involves passage of the maternal/foetal barrier, and the precise route is known only in the chick, the rabbit, the guinea-pig, the rat and man. Indeed, when I accepted the invitation to address you to-day it was not known in man, but to this I will refer again later, for since then a piece of work has been reported which I think solves once and for all the route in the primates, and presumably in man. Transference after birth is by way of the colostrum and, in some cases, by the milk as well, and the gut of the young animal.

The transmission of immunity in birds has been investigated chiefly in the hen. Circulating antibodies of an actively immunised hen are secreted from her circulation into the yolks of the eggs while they are still forming in the ovary. If the hen has been passively immunised by the administration of immune serum from another individual, then these antibodies also are secreted into the yolk of the egg. They remain in the yolk of the egg undigested so long as any yolk remains, that is, until the final absorption of all the yolk in the yolk-sac some 3 or 4 days after the chick hatches. The yolk-sac of the chick is a vesicle attached by the yolk-sac stalk to the intestine. While the chick is in the egg it hangs outside the body but is drawn within before hatching. It is vascularised by the vitelline circulation which runs up the yolk-sac stalk, and it is lined by endoderm like the rest of the gut. It is, in fact, an extension of the gut itself. Although there is a canal through the yolk-sac stalk that is said to remain open, the yolk does not pass through it into the intestine, and so the absorption of antibodies takes place through the endodermal lining of the yolk-sac itself and these are transported by the vitelline circulation.

Some mammals have a well-developed yolk-sac, although it contains practically no yolk. This is the case, for example, in the rabbit and in the rodents, such as the rat, guinea-pig and mouse, but in these animals one hemisphere of the vesicular yolk-sac disappears, so that the endodermal lining of the other hemisphere is directly exposed in the uterine cavity. It covers rather more than half the conceptus and it is vascularised by the vitelline vessels running in the yolk-sac stalk much as in the chick. The placenta, on the other hand, is vascularised by the allantoic vessels running in the allantoic stalk. Between the circulations of these two organs there is a zone of chorion which is almost avascular. It has been found to be experimentally possible, by making a small incision in the uterine wall on the side opposite to the mesentery and allowing the membranes to bulge out through it, to place a ligature on the vitelline vessels in such a way that the whole of the circulation of the yolk-sac is stopped in the majority of cases. If only alternate foetuses in the one uterus are treated in this way, and the intervening ones left intact, a preparation is obtained on which a crucial experiment on the route of transmission of immunity can be performed. When immune rabbit serum is administered to the mother intravenously in such a preparation, antibodies are found to pass to the circulations of the intact foetuses but not to those which have been ligatured. This is conclusive

evidence that antibodies reach the foetal circulation in the rabbit by way of the uterine cavity and the yolk-sac wall and not by way of the placenta. This finding was contrary to the accepted belief that antibodies are transmitted by way of the placenta, but this belief has rested in the past not on experimental evidence but on the morphological structure of the placenta, which is so obviously adapted as an organ of transference between mother and foetus. The route of transmission in the rabbit in fact is precisely comparable to that in the chick. The rabbit is an animal in which no immunity is transmitted after birth; even if immune rabbit serum of high titre is administered orally to the new-born rabbit, no antibodies reach the circulation from the gut. It appeared possible, however, that the gut of the foetus might be capable of absorbing antibodies though that of the new-born was not. Consequently, immune serum was administered directly into the amniotic cavity of foetal rabbits and the antibodies contained therein were found to accumulate in the gut, yet none reached the foetal circulation. Thus it must be concluded that the gut, both of the foetus and of the new-born rabbit, is incapable of absorbing antibodies, and that transmission occurs entirely by way of the yolk-sac wall.

The young rat obtains most of its passive immunity from the mother after birth, but some is transferred before birth. The rat resembles the rabbit in having a yolk-sac which is exposed to the uterine lumen during gestation, but it differs in that part of the yolk-sac endoderm closely invests the free surface of the placenta and even forms crypts, which extend into the substance of the placenta along the course of the principal allantoic blood vessels. The arrangement is such that the yolk-sac and placental circulations are not isolated from each other peripherally, as they are in the rabbit. Consequently, it is not possible to destroy the circulation to the whole of the yolk-sac by ligaturing the yolk-sac stalk as in the rabbit. It is possible, however, by cutting the yolk-sac close to the placenta, to remove it nearly completely, leaving only that part which is actually attached to the surface of the placenta. In such preparations the transmission of immunity is greatly reduced, though not completely stopped. By administering immune rat serum to the foetus orally, through a very small stomach-tube, it was found possible to show that the foetal rat, unlike the foetal rabbit, but like the new-born rat, is able to absorb antibodies from its gut. Thus, although transmission of immunity in the rat undoubtedly occurs *in utero*, both by way of the yolk-sac, as in the rabbit, and by way of the amniotic fluid and the foetal gut, it was not possible to demonstrate that no transmission occurs by way of the placenta, though it was possible to show that such transmission, if any, was, at most, only a small part of the whole.

The mouse resembles the rat so closely, both in the structure of its foetal membranes and in the transmission of immunity, that there can be little doubt that transmission occurs by the same routes as in the rat. The guinea-pig also resembles the rat in the arrangement of its foetal membranes, but, as you are aware, the young are born in a very much more advanced state of development. It is not surprising, therefore, to find that transmission of immunity in this species takes place entirely before birth and that it occurs, as in the rabbit and the rat, by way of the yolk-sac and not by way of the placenta. The dog is another species in which some immunity is transmitted before birth, though the greater part is transmitted after birth with the colostrum and the milk. We do not know the route by which immunity is transmitted from mother to foetus in the dog, and the arrangement of the foetal membranes is so different to that in the species we have been considering, that it is not possible to predict this on morphological grounds.

Transmission of immunity after birth by way of the colostrum and the milk and the gut of the new-born animal occurs in the rat, the mouse, the dog, in the ruminants, the horse and the pig; indeed in the ruminants, horse and pig transmission is confined to this route. In the rat and the mouse, it continues throughout lactation stopping only at the 20th day in the case of the rat and at the 16th day in the case of the mouse. In the dog it continues for 10 days whereas in the ruminants, the horse, the pig, as you will know, it is a very transient phenomenon that is limited to the first 24 to 36 hours of neonatal life. The antibodies are secreted by the mother in the colostrum and in the milk, often at concentrations that equal or even exceed those in the circulation. These antibodies are rapidly absorbed by the gut of the young animal and transmitted to its circulation. The young animal absorbs antibody as readily from immune serum, administered orally, as it does from milk or colostrum.

There are certain striking similarities in the process of transmission of immunity before birth and after birth in those species that I have already mentioned. First, transmission occurs before birth by way of the yolk-sac and in the rat by way of the foetal gut as well. Transmission after birth is, of course, always by way of the gut. Thus it occurs by way of the endoderm of the young animal, either that of the yolk-sac or of the gut, whether before or after birth. Another similarity is that in most species the process of transmission itself is highly selective in that certain serum proteins are transmitted readily whereas others are only transmitted at a reduced rate or not at all. Let me elaborate this point in relation to the foetal rabbit and the new-born rat. It will be realised from what I have said of the route of transmission in the rabbit that the absorptive surface of the foetal yolk-sac is exposed in the uterine cavity. By injecting directly into the uterine cavity mixtures of immune sera, prepared in different species against different antigens, it was possible to compare directly the rate of entry of the various antibodies. It was found that rabbit antibodies entered most readily, then human, guinea-pig, dog, horse and ox in that order. If the entry of rabbit antibody was taken as 100 per cent., then the relative entry of human antibody was 81 per cent., of guinea-pig 53 per cent., of dog 25 per cent., of horse 4 per cent. and of ox 1 per cent. This series shows clearly that we are not dealing merely with the acceptance of the homologous anti-

body and the exclusion of the heterologous antibodies. The degree of entry of each antibody is characteristic of the species in which it was prepared. A similar selection according to the species of origin of the antibody is shown by the yolk-sac of the chick and of the foetal guinea-pig and by the gut of the new-born rat and mouse. Other experiments performed with serum proteins labelled with radioactive iodine show that the selection is exercised also as between the various serum protein fractions, thus whereas γ-globulin enters most readily, albumen enters at a greatly reduced rate and β- and α-globulins cannot be detected as entering at all.

It would appear that this selective process is not a simple sieving on the basis of molecular size. This is shown in several ways. First of all, albumen enters less readily than γ-globulin, yet the molecular size of albumen is somewhere about 70,000, whereas that of γ-globulin is about 180,000. Moreover, in the rabbit, rabbit antitoxin enters readily, whereas rabbit antitoxin that has been pepsin-refined and of which the molecular size has been substantially reduced thereby, enters many times less readily than the natural antitoxin. Largely on these grounds we are of the opinion that transmission of immunity in these animals is a cellular process involving absorption of the protein molecules by the cells of the endoderm on the one side, and their secretion into the circulation on the other. The use of both antibody activity and radioactive isotopes as labels of the molecules in combination provides a satisfactory technique for investigating these cellular processes and the foetal rabbit and the new-born rat, two experimental animals that are particularly well suited to the purpose.

The arrangement of the foetal membranes in man, in which transmission occurs exclusively before birth, is quite unlike that in the animals already mentioned. The human conceptus during the later stages of pregnancy, when immunity is transmitted, is bounded by the placenta and the smooth membrane. Transmission must occur across one or other or both of these membranes. It could take place directly from the maternal to the foetal circulation across the placenta or from the maternal circulation to the amniotic fluid across either or both of these membranes. The amniotic fluid is swallowed by the gulping movements of the foetus and so antibodies within it will reach the foetal gut, where they might be absorbed. Direct transmission from the maternal to the foetal circulation across the placenta has always been assumed but without crucial evidence. Since the route of transmission in all other species in which it is known is endodermal, being either the yolk-sac or the gut, I was led to predict that in man it might occur by way of the amniotic fluid and the gut. This appeared the more probable because there is much evidence that transmission is selective in man, in the same sense as in the rabbit, the guinea-pig, the chick and the rat. On these grounds I emphasised that the comparative evidence from other animals favoured an endodermal rather than a placental route in man, but that there was no direct experimental evidence either way. The need for an experimental solution of the problem of the route of transmission in the primates was obvious.

Recently such evidence has been forthcoming from two sources. First, it has been shown by Wasz-Höckert and his collaborators in Sweden that new-born infants with oesophageal atresia, which hence could not have swallowed amniotic fluid, nevertheless had levels of diphtheria antitoxin in their sera comparable to those of their mothers. This finding would appear to exclude the stomach and intestine as a route of transmission of immunity in man before birth. Secondly, only a few weeks ago, Bangham, Hobbs and Terry in *The Lancet* have reported the results of experiments with isotopically labelled serum proteins in pregnant rhesus monkeys. They have shown that labelled γ-globulin is transferred directly from the maternal to the foetal circulation across the placenta and that no significant transfer occurs by way of the amniotic fluid and the foetal gut. Transference across the placenta is selective in that labelled γ-globulin is transmitted many times more easily than labelled albumen and neither α_2- nor β-globulins reach the foetus in detectable quantities. Only labelled albumen reached the amniotic fluid from the maternal circulation. Labelled maternal serum proteins were injected directly into the amniotic fluid from whence they reach the gut in fairly high concentrations, but they were not transmitted from there to the circulation of the foetus. Thus the problem of the route of transmission of immunity in primates has been solved at last by direct experiment and, in view of the close similarity of the placental structure in the rhesus monkey and in man, it may be concluded that the route in man is also transplacental and not by way of the amniotic fluid and the foetal gut. Evidently the primate placenta can perform the function of selective transmission of serum proteins which is performed in other animals by endodermal membranes.

I have digressed from the title of this address in so far as I have talked to-day about post-natal transmission of immunity, but I hope I have said enough to convince you that there are certain essential similarities in the process of passive transmission of immunity to the young, whether it occurs before or after birth. Consequently exploration of this field requires experiments both on the foetus *in utero* and on the new-born animal. Experiments on mammalian foetuses present certain difficulties that are immediately apparent, but which are by no means so great as they would appear at first sight. They are inevitably surgical, involving anaesthesia of the mother and an operation of some magnitude, including opening the body cavity to gain access to the uterus, and possibly opening both the uterus and the foetal membranes as well. If the experiment is to be performed on the living foetus, then the placental connexion must be maintained and the effects of the procedure on the foetus are complicated by those on the mother. Moreover, full aseptic precautions must be observed, if the experiment is to be of more than short duration. Foetal surgery must be on a proportionately small scale, and the experimental samples obtained are

likely to demand micro-methods of examination. Yet these difficulties are offset by certain very real advantages. First, the foetal mammal possesses powers of resistance to, and recovery from, surgical insult that are incomparably superior to those of the adult. For example, it can survive and recover from decapitation *in utero*. Secondly, it is in an aseptic environment so that the problem of the maintenance of asepsis does not present a too formidable difficulty. Thirdly, in animals such as the rabbit and the rat, which have many young in a litter, the experiment can be performed on some of the foetuses only while the others provide perfect controls, automatically maintained in the uterus under comparable environmental conditions. In fact, experiments on the mammalian foetus *in utero* are far easier than is commonly supposed and the field of foetal physiology is one that holds great promise. It is due to the pioneer work of Huggett and also of Barcroft and his collaborators at Cambridge, that interest in this field has revived.

In conclusion, I feel I must make some apology to you for talking on a subject that at first sight may seem far removed from your practical problems. Yet the mechanism of the transmission of immunity to the young animal bears on veterinary, as it does on medical practice, at a number of points. First, it relates directly to the immunological equipment of the young animal by means of which it resists infection. Secondly, it bears on haemolytic disease of the new-born, which occurs in the horse and pig as well as in man. Haemolytic disease results when the mother produces antibodies to foetal red-cell antigens which she does not possess. These antibodies, being transmitted to the young, either before or after birth, produce the disease. This disease occurs naturally in the horse, and is particularly well known to mule breeders, as well as in man. It occurs also in the pig but in this instance the immunisation of the mother is due to antigen conveyed in swine fever vaccination and does not appear to be natural. The disease can be produced experimentally in dogs and possibly it may be found to occur naturally in them. Thirdly, the transmission of immunity has important bearings on the problem of maintenance of uterine asepsis, a field which I have not had time to touch upon to-day. Fourthly, it provides a new approach to the problem of absorption, handling and secretion of proteins by the cells. It may well be that the most important advances in this field will be in this direction, but time does not permit me to discuss this aspect.

References

Full acknowledgement and references to all the literature quoted will be found in "The passive immunity of the young mammal" which is published in *Biological Reviews*, November, 1958.

Differential Diagnosis and Control of Respiratory Diseases of Poultry

BY

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THERE are a number of diseases which can affect the respiratory system of fowls. These include 5 virus diseases and at least an equal number of other infections, not to mention diseases due to faulty nutrition and management (see Fig. 1). In recent years further complications have arisen from the frequent occurrence of many of these diseases in a mild or atypical form together with the increase of the so-called "Chronic Respiratory Disease of Chickens," whose exact nature and aetiology has not yet been well defined.

Furthermore, the clinical picture of many of these diseases in the field can be modified or obscured by vaccination and chemotherapy. The possible implication of this on diagnosis is a very real one.

It is well recognised that these diseases are often confused in the field and that they are difficult to differentiate. It is certainly not easy to reach a definite diagnosis in an outbreak of respiratory disease on clinical grounds alone, nor is it easy to pin down the causal agent in the laboratory from one or two dead birds sent for *post-mortem* examination. Our experience, however, shows that many of these difficulties can be overcome by a combined effort of the field veterinarians and laboratory workers and a closer collaboration between the farm managers and field veterinarians. Here I would like to emphasise that the field veterinarians and farm managers have a very important part to play in the speedy diagnosis and timely control of respiratory diseases. They are the most important witnesses of a detective story. Furthermore, the success of laboratory examination depends largely on the timely dispatch of well-chosen specimens from the field.

In the present paper, an attempt will be made to show how various respiratory diseases can be diagnosed by the combined efforts of field and laboratory workers. A brief account will be given of the methods used for the identification of the various causal agents in the laboratory. Finally, the effect of the changing system of poultry husbandry on the epidemiology of various respiratory diseases together with the methods of control that are available will be discussed.

Diseases which may affect the respiratory system

First of all it may be helpful to refresh our memories about the diseases which may affect the respiratory system. Fig. 1 classifies these in 4 groups, according to their aetiology.

Group I comprises diseases due to faulty nutrition and management. Examples are the epithelial changes which characterise vitamin A deficiency, and conjunctivitis due to the irritant action of ammonia gas.

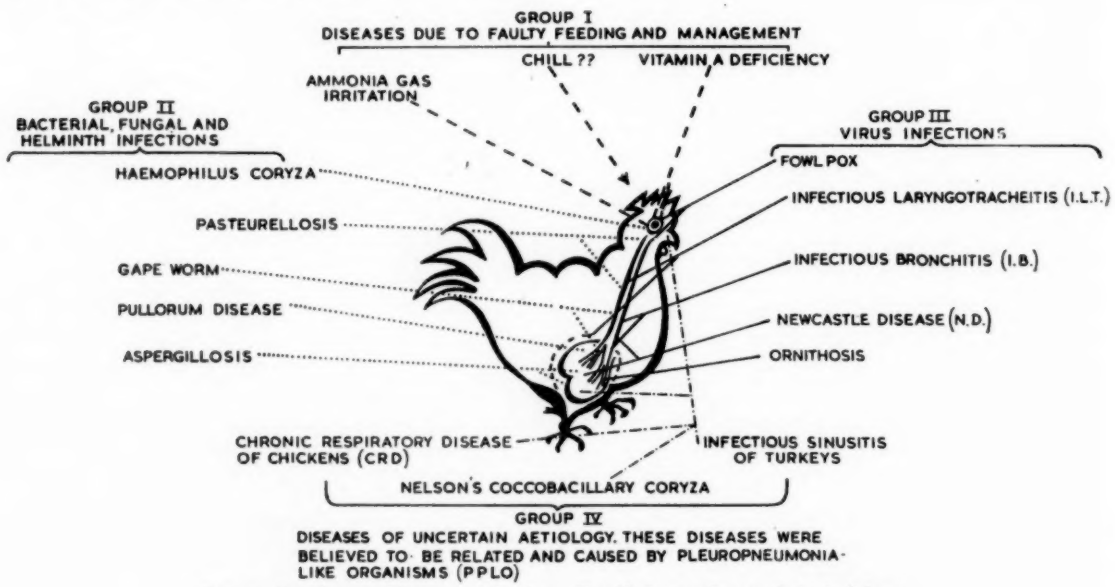


FIG. 1.—Respiratory Diseases of Poultry Classified according to their Aetiology.

Group II comprises bacterial, fungal and helminth infections; these include infectious coryza caused by *Haemophilus gallinarum*, acute and chronic pasteurellosis, pullorum disease (B.W.D.), aspergillosis and gape worm infestation. The causal agents of these infections are well defined and their identification presents little difficulty.

Group III comprises a number of viral infections, including Newcastle disease (fowl pest), infectious bronchitis, infectious laryngotracheitis (I.L.T.), fowl pox and ornithosis (psittacosis). The viruses concerned can all be cultivated in embryonated eggs and specific means are available for their identification.

Group IV comprises a number of chronic respiratory diseases whose aetiology is not yet well defined. These include an infectious coryza caused by coccobacilliform bodies described by Nelson (1936), chronic respiratory diseases of chickens (C.R.D.), first described by Delaplane & Stuart (1943) and infectious sinusitis of turkeys. When first described these diseases were thought to be caused by quite different agents but it is now believed that all three are due to pleuropneumonia-like organisms (P.P.L.O.) and are manifestations of the same disease.

It is not possible in a paper of this size to give a separate account of the various respiratory diseases. For a brief description of these diseases the general papers by Wilson (1954), Gordon (1956) and Chu (1958), together with standard text-books such as Biester and Schwarte (1952) may be consulted. For detailed information reference should be made to more specialised articles, such as the monograph by van Rockel (1950) on infectious bronchitis, papers by Seddon (1952) and Jordan (1958) on I.L.T. For infectious coryza, papers by Nelson (1936, a, b, c, d), de Blick (1948) and Chu (1954) and for C.R.D. a series of papers given at a symposium on Chronic Respiratory Diseases of Poultry (Adler, Fabricant, Yamamoto & Berg; Gross; Jungherr; Osborn & Pomeroy; van Roeckel, Olesnik & Beninato, 1958) may be consulted.

In the present paper I propose to describe the clinical, pathological and epidemiological features of these various diseases in a comparative way so as to provide some background information for our discussion on their differential diagnosis and control.

Fortunately, many of the diseases mentioned above occur only rarely, or can readily be identified. The main difficulty lies in the differentiation of those in the last two groups, namely the various viral infections and the chronic respiratory diseases of chickens. Our discussion will, therefore, be concentrated on these.

The rôle of field investigation in the differential diagnosis of an outbreak of respiratory diseases

Although the final diagnosis of an outbreak of respiratory disease depends on the laboratory identification of the causal agent, much useful information, invaluable for a speedy diagnosis, can be obtained from field investigation only. In this section I would like to discuss how the clinical and epidemiological picture of an outbreak can help in reaching a diagnosis.

Respiratory symptoms

In outbreaks of the above respiratory diseases the respiratory symptoms may vary from occasional sneezing among a few birds to severe coryza with gasping and râles affecting most of the birds. The severity and types of respiratory symptoms depend not only on the type of infection but also on the virulence of the causal agent, the age and general resistance of the birds and the systems of management. Generally speaking, an outbreak with mainly lower respiratory symptoms, *i.e.*, gasping and râles, etc., is more likely to be Newcastle disease, infectious bronchitis, I.L.T. or aspergillosis. The symptoms are usually more severe in I.L.T. On the other hand, outbreaks with obvious coryza symptoms, *i.e.*, running nose and swollen sinuses are suggestive of infectious coryza and C.R.D. Lachrymation and conjunctivitis may occur in most respiratory diseases and can be very serious in cases of I.L.T., fowl pox, C.R.D., vitamin A deficiency and ammonia gas irritation.

It is more important to look for the early respiratory signs than to watch for obvious advanced symptoms. The early syndrome of coryza may easily escape notice. It can, however, be readily detected by a close examination of the birds before they are fed and by squeezing the nostrils of the bird with the fingers when a bead of discharge will appear. Similarly, signs of a mild lower respiratory infection may only be detected at night or in the early morning when the birds are quiet and undisturbed.

In outbreaks involving both upper and lower respiratory passages, it is useful to note whether the disease starts from the nose or from the lower respiratory passage or from both. For instance, in infectious bronchitis and I.L.T. the disease usually starts mainly with lower respiratory symptoms. Later on, some birds may have chronic coryza usually as a result of secondary infection. On the other hand, in outbreaks of C.R.D. obvious coryza symptoms are usually present at the onset of the infection.

Needless to say, the detection of early respiratory symptoms is the key to speedy diagnosis and timely control of an outbreak. The farmer should be shown how to detect the early stages of respiratory infections so that he can call for advice before the infection has spread throughout the whole flock, without waiting until the symptoms become obvious as a result of secondary bacterial infection.

In infectious disease the clinical picture of the flock as a whole is more important than the symptoms and pathological lesions of an individual bird. Unfortunately, when farmers are asked to send birds for diagnosis they usually try to select what they call "a good specimen," usually a bird with a collection of varied complaints that are hard to find in the rest of the flock. For instance, one often receives a bird with its nostrils, eyes and sinuses filled with smelling cheesy exudate as a result of gross secondary bacterial infection. In other words, the so-called good specimen is often not the representative bird but the odd specimen in the outbreak. To judge the clinical picture of an outbreak on such material would be very misleading. In this

connection, the value of field investigation can well be appreciated.

Course of infection and incubation period

Table 1 compares the incubation period and the course of infection of some of the respiratory diseases. It can be seen that infectious bronchitis, *Haemophilus* coryza, Newcastle disease and I.L.T. have a short incubation period (2 to 6 days) and a short course (1 to 2 weeks), whereas the chronic respiratory diseases show a longer incubation period (5 to 21 days) and a prolonged course that may extend for several months. Some birds affected with infectious bronchitis, Newcastle disease or I.L.T. may show a prolonged course due to secondary bacterial infection. These would resemble cases of chronic respiratory disease.

Rate of spreading

The rate at which an infection is spreading may provide a useful guide to the diagnosis. Newcastle disease and infectious bronchitis are the most contagious and often spread rapidly to the whole flock. As all susceptible birds on a farm, even in separate houses, may become infected within a short space of time the infection may soon die out if no new batches of susceptible birds are introduced. Infectious coryza and C.R.D. usually spread very slowly unless the farm is heavily stocked. The disease may confine itself to one house and not spread to an adjoining house for some time. As the infected birds may remain carriers for a long period the infection may eventually spread to the whole flock and remain endemic for years unless the cycle of infection is broken by depopulation or strict isolation of the recovered birds. The rate of spreading of I.L.T. is more similar to C.R.D. than to Newcastle disease and infectious bronchitis. The infection spreads fairly rapidly among the birds in the same house or in the same field by direct contact, but it may take some time to spread to neighbouring houses if there is no direct contact between the birds. Some birds affected by I.L.T. may remain carriers for a long period, with the result that I.L.T. may become endemic in the flock and fresh acute outbreaks occur when new batches of birds are introduced.

In other words, infectious bronchitis and Newcastle disease usually occur in an epidemic form, and C.R.D. and I.L.T. in an endemic form.

Effect on Egg production

In an outbreak of the mild form of certain respiratory diseases a drop in egg production may be the only sign of the infection. Generally speaking, a sudden and sharp drop is more likely to be due to Newcastle disease or infectious bronchitis, while C.R.D. usually has a slower and more chronic effect on egg production. I.L.T. also has less effect. The reason for this difference is that infectious bronchitis and Newcastle disease virus have a direct effect on the reproductive organs, while in the case of C.R.D. the drop in egg production is due to the general debility and loss of appetite of the birds as a result of the prolonged infection. Furthermore, the more marked drop in egg production in an outbreak of Newcastle disease and infectious bronchitis may be partly due to the fact that most of the birds are affected at the same time, whereas in C.R.D. and I.L.T. it is usual for only parts of the flock to be infected at one time. In Newcastle disease and infectious bronchitis, the drop in egg production may be accompanied by the laying of mis-shapen, rough and thin-shelled eggs with watery albumin (Sevoian & Levine, 1958). Fig. 2 compares the drop in egg production in outbreaks of infectious bronchitis and C.R.D.

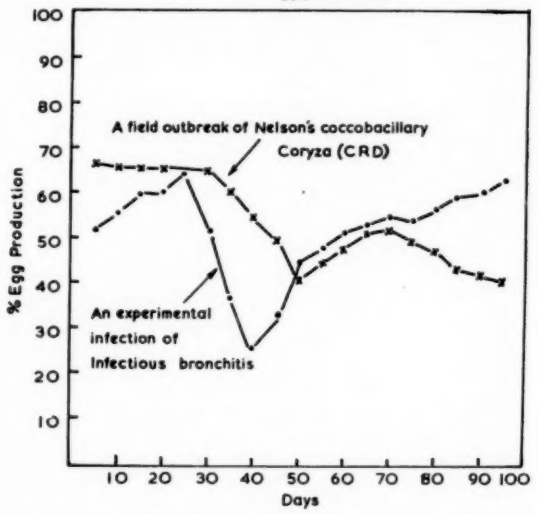
Effect on growth

C.R.D. has a more severe effect on the growth of affected birds than the other more acute infections, unless the latter are complicated by secondary infections. Fig. 3 shows that the average weight of two groups of birds infected with C.R.D. was 300 gm. less than the uninfected control 10 weeks after infection.

Mortality

The mortality resulting from various respiratory infections varies with the virulence of the infective agents, the age and the general condition of the birds and the standard of management. For instance, the mortality in an outbreak of Newcastle disease may range from none to 100 per cent. depending on the virulence of the strain. Generally speaking, sudden death with symptoms of gasping is suggestive of I.L.T. or acute Newcastle disease. However, mortality in young chicks may be due to any of the respiratory infections, including Newcastle disease, infectious bronchitis, I.L.T., aspergillosis, pullorum disease or C.R.D. On the other hand, mortality is usually low in adult birds affected with C.R.D., infectious bronchitis or mild Newcastle disease.

Fig. 2. Effect of respiratory diseases on egg production.



In the outbreak of C.R.D. aureomycin was given in the feed at a level of 75 grammes per ton starting at the time marked "a" for three weeks and continued at half this level thereafter.

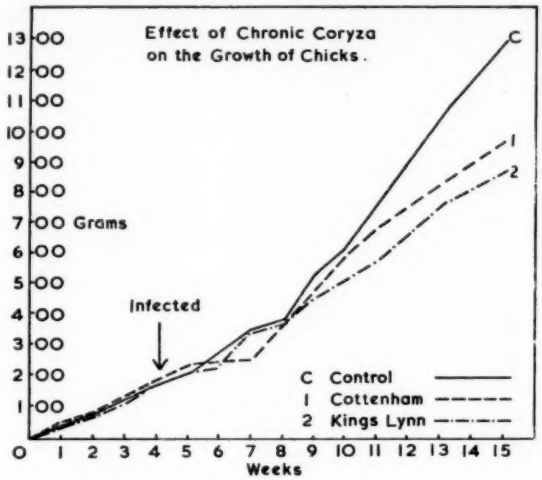


FIG. 3.—The graph compares the rate of growth of two groups of chicks infected with two field strains of chronic coryza or C.R.D. (marked 1 and 2) with one group of normal chicks (marked C). Note that the average weight of the infected chick 11 weeks after infection is 300 to 400 grammes less than that of the normal chick kept under the same conditions.

Age of infected birds

It has been suggested in the past that infectious bronchitis usually affects the baby chicks, but more recent experience has shown that this is not so. Birds of all ages seem to be susceptible to this infection and to most of the other respiratory diseases. However, the diseases may differ clinically in different age groups. Thus infectious bronchitis may occur in fully susceptible baby chicks resulting in severe respiratory distress and a considerable mortality, while in growers the respiratory symptoms may be so mild as to escape notice. In laying flocks the infection may only be evident by the drop in egg production. Similar situations occur in the mild form of Newcastle disease. I.L.T. has been described as affecting chiefly growers and adult birds. We have, however, found that the disease occurs in chicks of 3 weeks old in brooders causing a high mortality. C.R.D. can be seen in chickens of all ages.

In areas where certain diseases are endemic and in countries where vaccination is widely used, chicks may acquire immunity through antibodies present in the yolk. This immunity may persist for up to 3 weeks. Such chicks may resist infection or show only mild symptoms.

Symptoms and Pathological Lesions of Special Diagnostic Value

Although many clinical symptoms and pathological lesions are shared by most of the respiratory diseases there are certain features that are specific for certain infections and are of diagnostic value. (See Table V.)

Most of these diseases, however, often occur in an atypical or mild form with the absence of these characteristic clinical or pathological lesions. For instance, nervous symptoms may be absent in mild forms of Newcastle disease; mild infectious laryngotracheitis is often seen without the characteristic haemorrhagic tracheitis.

From the above discussion it can be seen that outbreaks of respiratory diseases can be roughly divided into two clinical categories.

The first category comprises outbreaks which affect mainly the lower respiratory passages without obvious nasal discharge or sinusitis. These outbreaks are likely to be due to infectious bronchitis, I.L.T., mild Newcastle disease or aspergillosis. If the infection spreads more rapidly, and has a relatively short course and a low mortality, but causes a severe and sudden drop in egg production in the laying flock, it is more suggestive of infectious bronchitis or Newcastle disease. If the outbreak is accompanied by considerable mortality with severe haemorrhagic or pseudo-membranous tracheitis and conjunctivitis it is likely to be I.L.T. Primary aspergillosis occurs mainly in poults kept in brooders under poor hygienic conditions. However, aspergillosis may only be a secondary complication of some other primary infection.

The second category comprises outbreaks which are accompanied by obvious coryza with nasal discharge and distended sinuses with or without lower respiratory symptoms. The disease usually has a prolonged course and a chronic effect on growth and egg production. The infection spreads rapidly in intensive poultry units, such as batteries, deep litter houses or broiler houses, but it does not spread readily from one house to the next provided the birds are kept indoors and there is little traffic between the houses. In less intensive farms the infection usually spreads slowly and tends to become endemic. Outbreaks of this type are likely to be C.R.D. Although the diphtheritic type of fowl pox and vitamin A deficiency may manifest themselves in a similar manner, they can be readily differentiated by a careful search for pox lesions and oesophageal nodules.

To sum up, one can say that a careful analysis of the clinical and epidemiological picture of an outbreak of respiratory disease, coupled with *post-mortem* findings, can go a long way in providing a diagnosis. Firstly, one should be able to decide under which of the two clinical categories the outbreak in question belongs. Secondly, it may be possible to make a tentative diagnosis so that immediate steps can be taken to prevent the further spreading of the infection and suitable specimens can be chosen for laboratory investigation which will aid in making a specific diagnosis.

Laboratory Methods for the Identification of the Various Causal Agents

Although the epidemiological, clinical and gross pathological findings can help a great deal in differentiating certain respiratory diseases, a definite diagnosis of a number of these diseases depends on the identification of the causative agent. The fact that most of these diseases tend to occur in a mild or atypical

form without their classical clinical and pathological features has made laboratory examination even more indispensable. Furthermore, laboratory examination is necessary to rule out the possibilities of a mixed infection.

Fig. 4 illustrates diagramatically the methods that we employ for the detection of the various organisms which may be associated with an outbreak of respiratory disease. These involve either the detection of the causal agent in the exudate from the respiratory tract or the demonstration of an increase of specific antibodies in the blood during the course of the infection. For the detection of the causal agent the specimen must be collected during an early stage of the infection because the chance of isolating certain infectious agents such as infectious bronchitis, I.L.T. or Newcastle disease viruses are greatly reduced a week following the onset of the symptoms. Even with C.R.D., where the causal organisms may be present in the sinus or trachea for a longer period, it is much easier to detect the organisms at the early stage when the disease is not complicated by secondary bacterial infection. For the demonstration of antibodies, two blood samples, one taken at the beginning of the infection and the other, one or two weeks later are usually necessary to reach a definite conclusion. If several batches of birds are affected, specimens from the earliest and the last affected batches will be useful.

Haemagglutination Inhibition (HI) test to rule out Newcastle Disease

In this country Newcastle disease is notifiable, and since it often occurs in a mild form with respiratory symptoms it is essential to eliminate the possibility of Newcastle disease in any outbreak of respiratory disease. The "HI" blood test for the detection of antibodies is officially used for this purpose. The test is carried out at the Weybridge and Lasswade laboratories. As a rule, Newcastle disease is ruled out before the outbreak is referred to us.

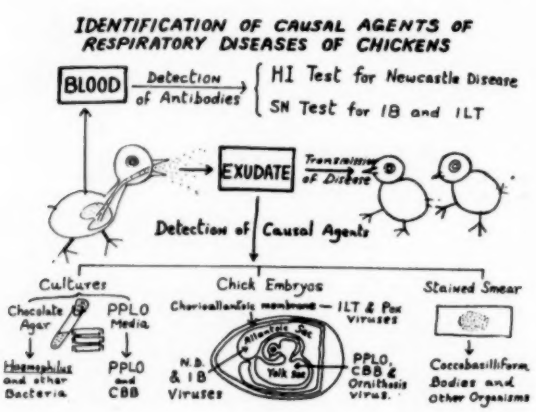


FIG. 4.

H.I. test = Haemagglutination Inhibition test.
S.N. test = Serum Neutralisation test.
I.L.T. = Infectious laryngotracheitis.
I.B. = Infectious Bronchitis.
N.D. = Newcastle Disease.
P.P.L.O. = Pleuropneumonia-like organisms.
C.B.B. = Coccobacilliform bodies.

Isolation of I.L.T. and Fowl Pox viruses

For the isolation of I.L.T. virus we use mucous membrane from the trachea or other infected tissue, such as conjunctiva. In the case of fowl pox, lesions of the comb, skin or mouth are used. If the mouth lesions are covered with cheesy exudate, the underlying tissue rather than the cheesy exudate should be used. This is ground in a Griffiths tube, or in a mortar with a little pyrex glass, with 2 ml. of nutrient broth containing 2,000 units of penicillin and 5 mg. of streptomycin sulphate per ml. The tube is allowed to stand in the refrigerator for one hour so that the glass powder and coarse particles can settle. The supernatant fluid is removed and dilutions of 1 in 10 and 1 in 100 prepared in broth containing penicillin and streptomycin. The undiluted and diluted suspensions are inoculated in 0·05 ml. amounts on to the chorio-allantoic membranes of 11 to 12-day embryonated eggs, using 2 eggs for each dilution. Half the eggs are opened after 3 days' incubation. If these give negative results the remainder are examined after a further 2 days' incubation. The growth of the viruses is indicated by the production of pocks on the chorio-allantoic membrane. The lesions produced by pox virus are usually more hyperplastic and oedematous while those produced by I.L.T. virus are more necrotic. Definite differentiation can be made by histological examination of the infected membrane. Pox virus is characterised by the presence of intracytoplasmic inclusion bodies while I.L.T. virus produces intranuclear inclusions.

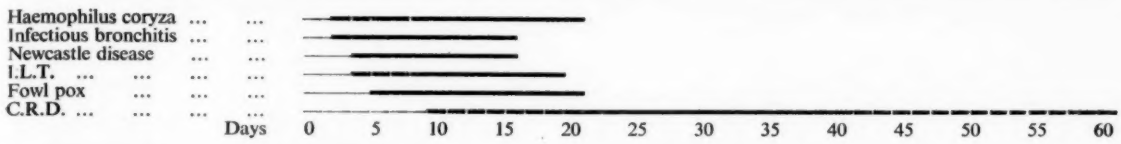
In our experience this method has proved very satisfactory for the diagnosis of I.L.T. and fowl pox. In the case of I.L.T. the specimen must be collected at the active stage of infection. It is advisable to use pooled material from several birds, some dead and some killed. Jordan (1958) also found the method satisfactory.

For general reference of egg technique the monograph by Beveridge and Burnet (1946), and for the growth of I.L.T. virus in embryonated eggs the paper by Burnet (1934), should be consulted.

Isolation of infectious bronchitis and Newcastle disease viruses

For the isolation of Newcastle disease virus a wide range of tissues, including tracheal exudate, lung, spleen, bone marrow and brain has been used. The choice of tissue depends on the nature of the outbreak and the stage of the infection. For infectious bronchitis, lung tissue and mucous membrane scraped from the trachea and bronchioles are used. A suspension of the infected tissue is prepared in broth containing penicillin and streptomycin by the method described above. The suspension is inoculated in 0.1 ml. amounts into ten 9 to 10-day embryonated eggs *via* the allantoic route. The eggs are candled twice daily. Evidence of the growth of the viruses of Newcastle disease is indicated by a more rapid embryo mortality and by the presence

TABLE I
INCUBATION PERIOD AND COURSE OF INFECTION OF VARIOUS RESPIRATORY DISEASES



——— Incubation period. ——— Course of infection.

The incubation period and course of infections shown in the table are only the average figures and they refer to infections with no secondary complications.

TABLE II
MORTALITY PATTERN OF CHICK EMBRYOS INOCULATED WITH INFECTED MATERIALS FROM FIELD OUTBREAKS OF INFECTIOUS BRONCHITIS AND NEWCASTLE DISEASE

Virus	Strain	Mortality of embryos (days following inoculation) 1	2	3	4	5	6	7	8	9	10	Embryos surviving after 10 days
Newcastle disease ...	Virulent		... ...	.. ..								None
	Mild			..	.. ..	..	.	.				None
Infectious bronchitis ...	1					.. .	.	.	.	.. .	.	None
	2								.	..	..	... ..

The charts compare the mortality pattern of ten 9-day embryonated eggs inoculated with the various field strains of viruses *via* allantoic sac. Each dot represents one egg.

TABLE III
THE DIFFERENCES BETWEEN THE PATHOGENIC COCCOBACILLIFORM BODIES RESPONSIBLE FOR TURKEY SINUSITIS, NELSON'S CORYZA OR C.R.D. AND OTHER AVIAN P.P.L.O.

	Pathogenic coccobacilliform bodies	Other avian P.P.L.O.
Sources of the organisms	Isolated from outbreaks of Nelson's coccobacillary coryza, turkey sinusitis or C.R.D.	Can be isolated from outbreaks of C.R.D. and any other respiratory infections and some apparently normal birds
Pathogenicity for chickens and turkeys	Produce coryza, tracheitis or air sac infections in chickens and turkeys	Fail to cause respiratory symptoms.
Morphology of the organisms ...	Mainly coccobacillary	Mainly ring, globules and bipolar bodies
Growth in Edwards P.P.L.O. agar ...	Small colonies mostly less than 0·1 mm. in 4 to 5 days, usually with no definite centre (Improved after sub-cultures)	Bigger colonies up to 0·5 mm. in 1 to 2 days with definite centres
Growth in Edwards P.P.L.O. broth ...	Granular growth in 3 to 5 days. (Improved after repeated sub-cultures)	More uniform growth in 1 to 2 days
Haemagglutination of chicken red cells	Positive	Negative
Effect on chick embryos following yolk sac inoculation	Cause an irregular pattern of mortality with respiratory syndromes in some of the embryos	Cause an irregular pattern of mortality, but do not produce respiratory syndromes in chick embryos
Serology	Sera against these types do not react with the non-pathogenic types	Sera against non-pathogenic P.P.L.O. do not react with the pathogenic types

TABLE V
DIFFERENTIAL DIAGNOSIS OF THE MAJOR RESPIRATORY DISEASES OF POULTRY

Diseases	Clinical and pathological features of diagnostic value	Laboratory methods for identification of causative agents
Vitamin A deficiency	Nodules on oesophagus, cheesy exudate in the eyes and urates in kidneys	Estimation of vitamin A storage in liver
Haemophilus coryza	Short incubation period (1 to 2 days) responds favourably to sulpha drugs treatment	Isolation of *Haemophilus gallinarum* on chocolate agar
Nelson's coccobacillary coryza or C.R.D.	Long incubation period (5 to 21 days) prolonged course, do not respond to sulpha drugs treatment. Obvious coryza syndrome	Demonstration of Nelson's coccobacilliform bodies in smears of sinus or tracheal exudate. Growth of the organisms in P.P.L.O. media or yolk sacs of embryonated eggs and differentiation of them from non-pathogenic P.P.L.O.
Fowl pox	Pox lesions on combs, wattles, eyelids and mouths	The virus produces pocks on chorio-allantoic membrane of embryonated eggs. It can be differentiated from I.L.T. virus by the presence of intracytoplasmic inclusion bodies in sections of the infected membrane
Infectious laryngotracheitis (I.L.T.)	Pseudo - membranous or haemorrhagic tracheitis, severe gasping and a fairly high mortality	Growth of the virus on chorio-allantoic membrane of embryonated eggs. The virus produces pocks on the membrane but it can be differentiated from fowl pox by the presence of intranuclear inclusion bodies
Infectious bronchitis	Short incubation (1 to 3 days) brief course and low mortality. Symptoms mainly sneezing and gasping	Growth of the virus in allantoic cavity of embryonated eggs. The virus causes dwarfing and curling of the embryos. Detection of antibodies in affected birds by serum neutralisation test
Newcastle disease...	The mild form is similar to infectious bronchitis but some birds may show nervous symptoms. In virulent form, there is high mortality with haemorrhage on heart proventiculus and intestine	Growth of the virus in allantoic cavity of embryonated eggs. The virus can be identified by their ability to agglutinate red cells. Detection of antibodies in affected birds by HI test
Aspergillosis ...	Yellow-white nodules in bronchioles and lungs and saucer-shaped lesions with depressed centres on air sacs. Larger lesions may show the characteristic greenish mouldy appearance	Demonstration of the aspergillus in tissues and growth of the fungus in the Sabouraud's medium

of haemagglutinin in the allantoic fluid. The growth of infectious bronchitis virus is indicated by the dwarfing and curling effect on the embryos with slower mortality and by the failure of the virus to cause haemagglutination. The dwarfing effect might not be evident until one or two passages and the rate of mortality will increase after continuous passage. Table II compares the mortality pattern of chick embryos inoculated with 2 field strains each of infectious bronchitis and Newcastle disease. For further information the paper by Fabricant (1950) should be consulted.

Detection of Ornithosis (Psittacosis) virus

In outbreaks of lower respiratory infection in turkeys, pigeons and ducks, the possibility of ornithosis must be ruled out. Isolation of ornithosis virus is best accomplished by intracerebral inoculation of mice, although the virus can also be grown in 5 to 7-day embryonated eggs following yolk sac inoculation. The growth of the virus is indicated by death of the mice or chick embryos and can be confirmed by demonstration of the virus in touch preparations of the infected brain or yolk sac stained by Giemsa's, Macchiavello's or Castaneda's methods. Complement fixation tests and indirect complement fixation tests have also been used for the diagnosis of ornithosis. For detailed information the intensive work by Meyer (1952) should be consulted.

Serum Neutralisation test for infectious bronchitis

The fact that our investigation on an outbreak of respiratory disease has to wait until Newcastle disease has been ruled out by HI test, has made the diagnosis of infectious bronchitis on the isolation of virus rather difficult, because, by then, the active infection might have subsided and it would be rather difficult to isolate the virus. For this reason the diagnosis, in most cases, has to depend on the detection of antibodies in the affected birds by serum-neutralisation test. The method which we employed was essentially that described by Cunningham (1951) and Fabricant (1951).

The Beaudette strain of infectious bronchitis virus was chosen for the neutralisation test, because it kills embryos regularly on the second day after inoculation. A standard virus preparation was prepared as follows: pooled allantoic and amniotic fluid collected from embryonated eggs 36 hours after infection was kept in bulk in a mechanical refrigerator at −30° C. overnight. It was thawed at room temperature and centrifuged at 2,500 r.p.m. for 10 minutes to remove the precipitate. The clear

DR. H. P. CHU.—DIFFERENTIAL DIAGNOSIS AND CONTROL OF RESPIRATORY DISEASES OF POULTRY

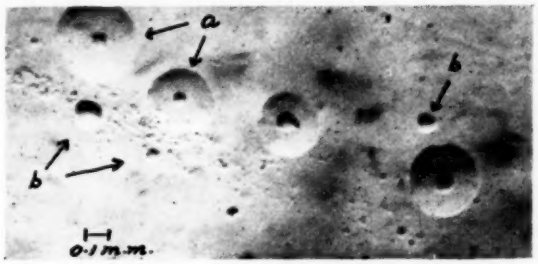


FIG. 5 (a and b).—Two types of colonies grown on P.P.L.O. agar from sinus exudate of a chicken naturally infected with Nelson's coccobacillary coryza or C.R.D. The four bigger colonies with distinct nipples on the centre marked "a" are the non-pathogenic P.P.L.O. and the smaller colonies without a clear-cut central structure marked "b" are the pathogenic coccobacilliform bodies. × 50.

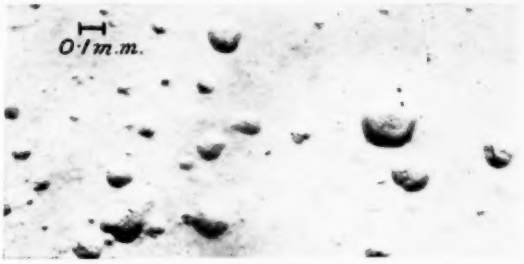


FIG. 5 (c).—Colonies of a strain of turkey sinusitis agent. Note the similarity of these colonies to those produced by the coccobacilliform bodies of fowl coryza as shown in Fig. 5 (b). × 50.

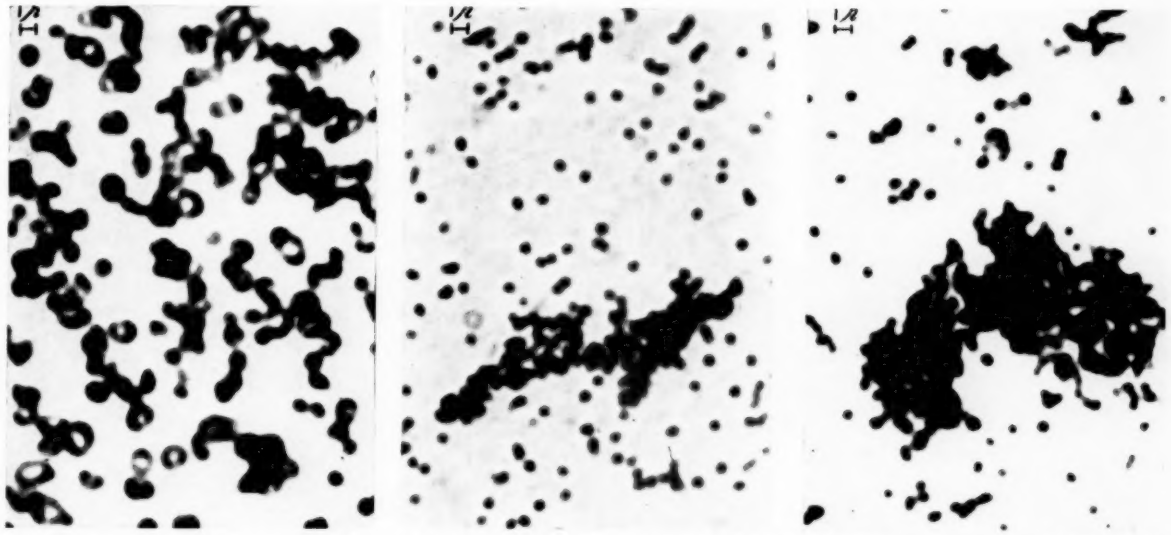


FIG. 6.—Comparison of the morphology of the three strains of organisms shown in Fig. 5. The smears were made from broth cultures inoculated with a single colony and stained by Giemsa's method. × 3,500.

(6a).—The non-pathogenic P.P.L.O. consisting mainly of rings and bipolar bodies.

(6b).—The pathogenic strain from fowl coryza consisting mainly of coccobacilliform bodies.

(6c).—The pathogenic strain from turkey sinusitis also consisting mainly of coccobacilliform bodies.

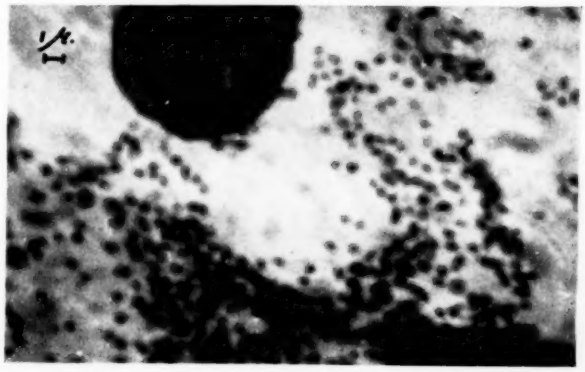


FIG. 7 (a).—A smear of sinus exudate from a chicken naturally infected with Nelson's coccobacillary coryza or C.R.D. Note the presence of a large number of coccobacilliform bodies. Compare their size with the nucleus on the top left corner. × 3,500.

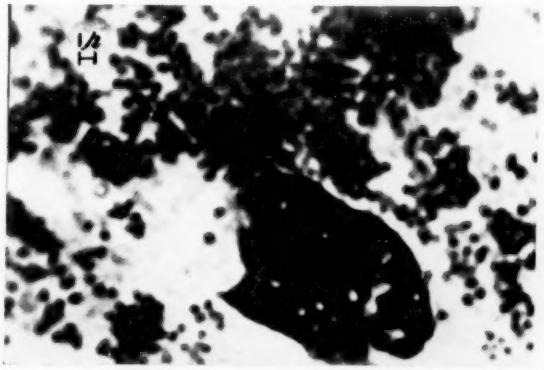


FIG. 7 (b).—A smear of sinus exudate from a chicken experimentally infected with a 7th-passage broth culture of a strain of coccobacilliform bodies isolated from a case of C.R.D. Note the presence of a large number of coccobacilliform bodies similar to those present in the broth culture (Fig. 6b) and in the naturally infected chicken (Fig. 7a). × 3,500.

supernatant was then dispensed in 1 ml. amounts in small tubes and sealed with paraffin. The tubes were kept in the −30° refrigerator. The virus preparation retains a titre of 10^{-4} to 10^{-5} for a period of over one year. In our experience the initial freezing and thawing followed by the removal of the precipitate formed, although reducing the final titre of the virus, seems to produce a more uniform and stable virus preparation.

For our routine serum neutralisation test a tube of the virus was thawed at room temperature. Serial 10 fold dilutions of the virus ranging from 10^{-1} to 10^{-5} were prepared using nutrient broth containing 1,000 I.U. of penicillin and 5 gm. of streptomycin per ml. as the diluent. The serum was diluted 1 in 10 with the same diluent. 0·5 ml. of 1 in 10 serum was added to 0·5 ml. of each of the virus dilutions. The virus-serum mixture after shaking was incubated at room temperature for 30 minutes. 0·1 ml. of the mixture was then inoculated into 9 to 10-day embryonated eggs *via* the allantoic sac using 3 eggs for each dilution. The eggs were incubated at 37 to 37.5° C. and candled daily for mortality. The ID_{50} was determined according to Reed & Muench (1938). The amount of virus, expressed as numbers of ID_{50} neutralised by 0.5 ml. of the 1 in 10 serum, was taken as the neutralisation index of a serum.

In our experience the neutralisation index of normal serum seldom exceeds 10. With serum from birds exposed to the infection the neutralisation index does not differ significantly from normal serum in the first 10 days following infection. Definite increase was noted in some birds 2 weeks after infection, but in the third week the majority of the birds should have a neutralisation index of more than 100 and some of them may exceed 10,000.

In view of the considerable variation in the antibody response among individual birds 2 samples of pooled sera from 5 birds each were used in our routine diagnosis. Sometimes, it is necessary to test another sample, collected one or two weeks later. As a rule, we regard a neutralisation index of less than 10 as negative, between 10 and 100 doubtful and over 100 as positive. This is in line with Cunningham (1951) who showed the neutralisation index of 0.5 ml. of undiluted normal serum as less than 32.

It is important to include a known positive and a normal serum control in each series of tests.

The Aetiology and Laboratory Diagnosis of C.R.D. (including turkey sinusitis and Nelson's coccobacillary coryza).

The current view is to regard C.R.D., Nelson's coryza and turkey sinusitis as a single disease caused by a pleuropneumonia-like organism (P.P.L.O.). Hence the isolation of P.P.L.O. has been used as a criterion for the diagnosis of C.R.D. The specificity of such a method is questionable in view of our finding that typical P.P.L.O. can be found not only in chickens suffering from C.R.D. but also in chickens affected by most of the other respiratory diseases and in some apparently healthy chickens. We have, however, shown that the coccobacilliform bodies responsible for infectious coryza or C.R.D. which are now referred to as P.P.L.O. (Nelson, 1953) are very different from the saprophytic P.P.L.O. which can be found in other conditions. The pathogenic types grow more slowly in Edward's P.P.L.O. media and cultures of it, consisting mainly of coccobacilliform bodies, are pathogenic for chickens. (See Figs. 5b, 5c, 6b, 6c.) The saprophytes, on the other hand, grow more rapidly and in cultures, consist mainly of rings, globules and bipolar bodies and are not pathogenic for chickens. (See Figs. 5a and 6a.) These results suggest that there are at least 2 types of P.P.L.O. in poultry and that a specific type is responsible for infectious coryza or C.R.D. The coccobacilliform bodies appear to be such a specific type. This suggestion has since been confirmed by our serological and other investigations undertaken by Miss Newnham who has shown that the pathogenic coccobacillary types isolated from chickens with Nelson's coryza or C.R.D. and turkeys with infectious sinusitis are serologically quite different from the non-pathogenic P.P.L.O. which can be readily found in birds with or without C.R.D.

In view of this finding our diagnosis of infectious coryza or C.R.D. has been based on the identification of the pathogenic coccobacilliform bodies rather than on the isolation of P.P.L.O. in general. The methods which we employed for this purpose are:

(1) Direct demonstration of the organisms in smears of sinus or tracheal exudate stained by Giemsa's method. It is important that the birds must be at the early stage of infection when the sinuses or trachea contain mucoid exudate and not smelling cheesy material. It is advisable to make smears from birds freshly killed rather than from birds received dead at the laboratory since these may have *post-mortem* bacterial contamination. With suitable specimens, well defined coccobacilliform bodies in small groups or in large clumps can be readily detected. (See Fig. 7.) Some of the organisms are found inside leucocytes.

(2) Cultivation of the organisms in P.P.L.O. media and the differentiation of them from non-pathogenic P.P.L.O. by the criteria set out in Table III and illustrated in Figs. 5 and 6. Edwards P.P.L.O. media with 20 per cent. horse serum (1947) have been used as our standard media. However, we have found that the Brucella agar or broth (prepared by Albimi Laboratories) with the addition of 20 per cent. horse serum can be used as a substitute. This finding is useful because these Brucella media are available in most veterinary laboratories. These media were first used by Dr. Whittlestone in our laboratory for growing P.P.L.O. from pigs.

(3) Transmission of disease to experimental birds. Sometimes the specimens may be so badly contaminated by secondary bacterial infection that direct demonstration or growth of the organisms was difficult. In such cases, it may be necessary to infect a few chickens or turkeys with the exudate. The birds are inoculated intranasally, intrasinusly and intratracheally. The exudate can be treated with penicillin and thallium acetate to inhibit the contaminating bacteria. If the pathogenic coccobacilliform bodies are present in the exudate, the inoculated turkeys will develop sinusitis within a

week. It may take longer for the chickens to develop obvious symptoms, but *post-mortem* examination may reveal early sinusitis, rhinitis or tracheitis before nasal discharge is evident. Coccobacilliform bodies in small clumps usually can be demonstrated in smears of the exudate at this stage.

Because of our finding of the frequent occurrence of non-pathogenic P.P.L.O. in poultry we have for a long time been puzzled that across the Atlantic all avian P.P.L.O. were considered to be responsible for C.R.D. It is indeed a relief to note in some recent papers that the existence of non-pathogenic P.P.L.O. has also been recognised in America. (Yamamoto & Adler, 1958, a and b.) These authors showed that a number of P.P.L.O. which were isolated from cases of C.R.D. have now proved to be non-pathogenic and serologically different from the pathogenic strains. It is interesting that their pathogenic strains also appeared mainly as coccobacilliform bodies and were more difficult to grow, while their non-pathogenic strains grew more rapidly and consisted of rings, globules and bipolar bodies. This agrees very much with our findings. (Chu, 1954, 1958.)

If the isolation of the pathogenic P.P.L.O. instead of any P.P.L.O. is used for the diagnosis of C.R.D., the disease might not be as widespread in America as has been reported. Similarly, if the attempts to control C.R.D. aim only at the elimination of the pathogenic P.P.L.O., *i.e.*, Nelson's coccobacilliform bodies rather than all P.P.L.O. the task might not be as discouraging as it has been.

However, there is still another issue concerning the aetiology of C.R.D. The issue is whether P.P.L.O. is the only causal agent of C.R.D., or whether some other agents are also involved. A virus has been isolated from outbreaks of C.R.D. by Fahey & Crawley (1954), a similar virus was also found in turkey sinusitis (Fahey, 1956). These viruses can be cultivated in chick embryos and produce small pock lesions on the chorioallantoic membrane. The nature of these viruses and their rôle in C.R.D. of poultry has yet to be clarified.

Furthermore, the importance of *Escherichia coli* as primary or secondary pathogen in certain outbreaks of C.R.D. has recently been emphasised (Gross, 1958; Gordon, 1958).

Identification of other infective agents. For the identification of bacteria and fungus associated with respiratory diseases the usual cultural methods are used as shown in Table IV.

Incidence of Respiratory Diseases of Poultry in England

When I was asked to present a paper to the Congress, the subject suggested was "the incidence of respiratory diseases of poultry." I felt that, although we have investigated quite a number of outbreaks of respiratory disease during the last few years, our cases by no means represent the cross section of the diseases in the country as a whole. In my view, until differential diagnosis of respiratory diseases on an aetiological basis can be carried out routinely, it would be impossible to talk about the incidence of respiratory diseases with any certainty. That is the reason why in this paper I choose to talk about differential diagnosis and control.

However, during 1957-58, outbreaks from a wide area were referred to us through Weybridge, Houghton and Veterinary Investigation Centres. The incidence of various respiratory diseases identified in 30 of such selected outbreaks from various parts of the country are shown in Table IV. It can be seen that there were as many cases of infectious bronchitis as of C.R.D. and that I.L.T. was also very common.

TABLE IV

THE INCIDENCE OF VARIOUS RESPIRATORY INFECTIONS DETECTED IN 30 SELECTED OUTBREAKS INVESTIGATED IN ENGLAND DURING 1958-59.

Diseases	*Incidence*
Infectious bronchitis	12
Chronic respiratory disease (Nelson's coccobacillary coryza)	11
Infectious laryngotracheitis	8
Fowl pox	1
Aspergillosis	1

In two outbreaks both infectious bronchitis and C.R.D. were identified; in another outbreak both infectious bronchitis and I.L.T. were found.

Prevention and Control

Prevention is better than cure. This is especially so when poultry and respiratory infections are concerned. Many respiratory infections are caused by viruses for which no effective drug is yet available. Moreover, the task of treating large groups of birds raises practical and economic difficulties.

There are two ways of preventing infectious diseases. One is by excluding the infectious agents from the flock or, if possible, from the country altogether. The other is by vaccination. Each has its advantages and its problems. The choice depends on how widespread the disease is in the country.

In some countries where Newcastle disease and infectious bronchitis are widespread the main control measure adopted is that of vaccination. Several types of Newcastle disease vaccine have been developed. Some are administered by parenteral route (Iyer & Dobson, 1940; Komarov & Goldsmidt, 1946; van Rockel, 1955). Others are given by dropping into the eyes or nose, by adding to the drinking water or by spraying over the birds (Johnson, 1955). Similar vaccines are used for infectious bronchitis (Crawley, 1955; Raggi & Bankowski, 1956). Vaccination against I.L.T. employs a fully virulent virus grown in chick embryo. This is applied by brushing on to the mucous membrane of the cloaca. The vaccinated birds have to be kept in isolation until the active reaction is over to prevent the infection spreading to unvaccinated birds. A vaccine prepared from a mild field strain has recently been developed by Pulsford, Chamberlain & Topham (1957) in Australia.

One of the most difficult problems connected with the production of a living virus vaccine is the adjustment of the virulence and the dose of the viruses in the vaccine to meet a wide range of birds which may vary greatly in their general resistance and state

of immunity to the disease. A serious complication in using living virus vaccine prepared with embryonated eggs is the possible contamination by other egg-borne infectious agents, such as viruses of avian encephalomyelitis (Cottral, 1953) and visceral lymphomatosis (Burmester, Cunningham, Cottral, Balding & Gentry, 1956) and C.R.D. agent (van Roeckel, 1953. Furthermore, there is a strong indication that the use of living Newcastle disease or infectious bronchitis vaccine may, on occasions, precipitate outbreaks of chronic respiratory diseases. This shows that the use of living virus vaccine for the control of respiratory infection is not a simple task. Moreover, some of the infections may become endemic following the use of a living virus vaccine.

In this country, Newcastle disease (fowl pest) is controlled by the slaughter policy in order to keep the virus from becoming established in this country. A vaccine is available for the control of fowl pox. This utilises a pigeon pox virus. The vaccine is safe and effective.

No official policy has been formulated for the control of other respiratory diseases. One reason is that respiratory diseases did not constitute a serious problem in the past when poultry were kept in small units. However, with the rapid development of the intensive system of poultry production the problem has become more evident, and is likely to become more so as the industry grows. Our experience suggests that the mild "summer colds" encountered under the old extensive systems have become the severe and damaging outbreaks of chronic respiratory disease seen under the present intensive systems. In a big modern poultry farm where large numbers of birds are kept in close contact, any infection introduced will soon spread to the whole flock. If this occurs on a supplying farm, the infection will quickly spread to a large number of other farms over a wide area. This is a problem requiring special attention.

I feel the time has come for the industry as a whole to take more positive measures in the control of respiratory diseases, otherwise it will soon be too late for effective action to be taken. First we must assess the disease position on a national basis. We then have to decide which measures are to be adopted for the control of the major respiratory infections, namely infectious bronchitis, infectious laryngotracheitis and chronic respiratory disease of chickens. If we choose vaccination, then we must be prepared to meet all the problems and complications which may arise with the use of living virus vaccines. The alternative would be to double our effort to bring the diseases under control by certain quarantine and sanitary measures coupled with sound husbandry. In my view, the latter method may be supplemented by the use of killed vaccines in areas where the diseases are widespread. We are at the moment experimenting on killed vaccines for I.L.T. and infectious bronchitis.

In the meantime, I would like to suggest a few practical measures which may help at least to keep the various respiratory diseases in check.

In the modern poultry industry, the bulk of chicks are supplied by big commercial hatcheries which, in turn, are supplied by a small number of big breeding farms. It appears that the prevention and control of disease in these supplying farms is the key to the eradication or reduction of respiratory infection. In my experience, these supplying farms are fully conscious of their special responsibility and are anxious to avoid respiratory disease in their flocks.

To secure the active collaboration of these farms either through the stock improvement plan or through some other organisation is the most important single step towards controlling respiratory diseases or, in fact, any infectious diseases.

Firstly, an attempt must be made to clear up any infections which may be present in supplying farms, whether in an active or latent form.

Secondly, steps must be taken to prevent the introduction of infectious agents into these flocks. Infectious agents can be introduced by various means, but the purchase of adult birds or growers as replacements is probably the most common. If this is necessary the purchased birds should be kept in isolation for a period of time. A small number of birds from the farm should then be brought into contact with them to see whether the purchased birds are carriers of diseases, such as I.L.T. or C.R.D. Special precautions must be taken to prevent the introduction of infections through garbage, crates returned from the market, and through animals or man, especially poultry dealers.

Thirdly, a constant watch must be kept on the flock so that any outbreak of respiratory disease is detected with the least delay and prevented from spreading. Apart from respiratory symptoms, records of egg production, mortality and rate of growth are useful guides for the detection of disease. In fact, the production record is sometimes the only way of detecting a mild or chronic infection. In a big flock a separate record should be kept for each pen or house. Such records enable one to follow the health of different batches of birds in different parts of the farm and to detect and control any disease or outbreak as soon as it arises.

Fourthly, if an outbreak does occur, the most important thing is to prevent the infection from spreading further within the farm or to other farms. The affected birds must be kept in quarantine until the active infection is over. If outbreaks occur in a big hatchery or broiler plant it is advisable to stop hatching or to suspend the introduction of new batches of chicks to the infected units until the infected birds have been removed and the infection is brought under control.

The infected birds may remain carriers for various lengths of time depending on the nature of the disease. I.L.T. and C.R.D. are diseases in which chronic carriers are common. In outbreaks of these diseases depopulation is the best way of preventing recurrence of the disease. If, for some practical reason, this cannot be done, then both the recovered and in-contact birds must be kept in isolation as far as possible from the replacement stock. Separate attendants and utensils are necessary. In any case, it is advisable to dispose of the recovered birds as

soon as practicable. Needless to say, following an outbreak, the premises and utensils should be thoroughly cleaned and disinfected in the usual manner.

Fifthly, it is advisable to keep chicks and growers away from adult stock. A number of infections such as C.R.D. and I.L.T. can persist in a flock year after year through adult carriers. The fact that chicks can be reared in complete isolation from the adults should provide a practical way of breaking the cycle of infection except for those infections which can be transmitted directly through the eggs. Curiously enough, full use has not been made of this advantage for the control of poultry disease.

The agents of C.R.D. and turkey sinusitis have been shown to be egg-transmitted (van Roeckel, 1953; Mataney, Pomeroy & Osborn, 1955). However, egg transmission of the disease did not occur consistently in every hatch of chicks and C.R.D.-free progeny have been raised from infected hens and maintained free of the disease for at least 12 months (van Roeckel, 1958). We have had experience of building up two big breeding flocks of 4,000 adult stock clinically and pathologically free from C.R.D. using 12,000 eggs from hens recovered from a severe outbreak of C.R.D. These flocks have remained free from respiratory diseases for the last 3 hatching seasons. This rather encouraging result seems to suggest that in practice the problem of egg transmission of C.R.D. might not be as serious as one would expect from the ease with which the agent has been found to pass through the eggs.

Finally, I would like to emphasise that good management and hygiene are indispensable for disease prevention and control. This is especially important on an intensive poultry farm. To keep a continuous flow of susceptible birds under overcrowded and unhygienic conditions without adequate precautions against disease is asking for trouble.

Our optimism in the prevention and control of C.R.D. or turkey sinusitis was strengthened by the ease with which we have been able to keep our normal chickens and turkeys from picking up any infection during the last 6 years in spite of their close proximity to a fairly large number of chickens and turkeys actively infected with C.R.D. This is even more surprising since both the normal and infected birds have been looked after by the same person. The only precaution was that he handled the birds as little as possible and that he fed the normal flock first before he went into the infected units, which are only about 50 yards from the hut housing the normal birds. This shows that these infections do not spread readily except by direct contact between the birds. In this respect they are very different from infectious bronchitis and Newcastle disease.

Antibiotics or other chemotherapeutic agents have a definite place in the treatment and control of certain respiratory diseases caused by bacteria. Fowl coryza caused by *Haemophilus gallinarum* responds favourably to treatment with sulphathiazole and streptomycin. In the early days fowl coryza caused by coccobacilliform bodies and turkey sinusitis were shown to respond favourably to treatment with streptomycin, oxytetracycline and chlortetracycline. However, numerous recent reports on the treatment of these chronic respiratory diseases with various antibiotics are rather disappointing. These drugs have also been used in checking secondary bacterial infection following other respiratory infections.

Unfortunately, these valuable drugs have not always been properly used. Very often they are used at such a low level as not to have much therapeutic value, but may render the organisms more resistant to the drug. We have recently come across a number of outbreaks of turkey sinusitis which did not respond to treatment with the antibiotics at all, because the organisms concerned had become resistant to the drugs. In my opinion these drugs must be used at an effective concentration over a short period. Furthermore, after completion of the treatment all the birds must be examined individually to eliminate those which do not respond, otherwise they may provide a further source of infection for those which have responded to the treatment. If facilities are available the eliminated birds may be kept in isolation and treated with another drug. If they still fail to respond, then it would be better to cull them, because they are likely to harbour a drug resistant strain and it would be unwise to keep them. In view of the frequent occurrence of resistant strains in the field, it is advisable to treat a small number of birds as a trial before a large scale treatment of the whole flock is carried out.

Some Examples of Field Outbreaks of Respiratory Diseases and Their Diagnosis and Control

All the clinical symptoms and diagnostic methods which we have been discussing would sound rather empty and confusing unless they could be illustrated by some actual outbreaks. I would like to conclude my paper by describing in some detail how we made use of the field and laboratory investigations described above to arrive at a definite diagnosis in 3 outbreaks of respiratory diseases, one of infectious bronchitis, one of infectious laryngotracheitis and one of chronic respiratory disease of chickens. These outbreaks will also serve to illustrate the epidemiology and control of these 3 major respiratory infections.

Outbreak Number 1

A big breeding farm—with breeding stocks kept in deep litter houses, growers at range and chicks in an intensive brooding plant.

For 2 or 3 years a mild respiratory infection has been noted in this flock. The mortality has never been high, but from time to time clinical symptoms associated with lower egg production, have developed. A similar outbreak occurred in the winter of 1956 in 2 deep litter houses. The outbreak did not respond to treatment with oxytetracycline and chlortetracycline. About 2 months after the onset of the outbreak an affected hen was submitted alive for laboratory examination. *Post-mortem* examination revealed severe rhinitis, sinusitis, tracheitis and caseous exudate in the air sacs. The clinical and pathological pictures were typical of

C.R.D. A P.P.L.O., together with some miscellaneous bacteria, were isolated from the tracheal exudate, but coccobacilliform bodies were not found in the stained smear of the exudate. Six growers inoculated with the exudate did not develop any respiratory disease. Egg inoculation also failed to isolate I.L.T., infectious bronchitis or Newcastle disease viruses. The HI test for antibodies against Newcastle disease was negative, but a high level of antibody against infectious bronchitis was demonstrated by a serum neutralisation test. The results of these laboratory investigations suggested that the bird had had infectious bronchitis, but it was not possible to say from the result that infectious bronchitis was the sole cause of the outbreak. A visit was made to the farm. No obvious respiratory symptom was present in the birds in the 2 affected houses, but the egg production remained below 50 per cent. Blood samples were collected from 6 birds picked at random from each of the houses. Neutralisation tests showed the presence of high level antibodies against infectious bronchitis in all 6. Antibodies were also detected in sera of some of the growers at range.

During the visit, it was learned from the manager that throughout the hatching season, sneezing had been apparent in a few odd chicks when one went into the brooding plant at night. The chicks as a whole were, however, doing very well and there had been no abnormal mortality. He was asked to pick out a few of these chicks for laboratory examination. Two batches of 6 chicks were received. Some showed a slight gasping. *Post-mortem* examination revealed the presence of a sero-mucoid exudate in the trachea and bronchioles, while in one chick the thoracic air sac was thickened. The exudate was inoculated into 9-day embryonated eggs *via* the allantoic sac. A dwarfing effect was noted in the embryos with some mortality at 6 to 10 days post inoculation. A virus typical of infectious bronchitis was isolated and its identity confirmed by serum neutralisation with infectious bronchitis immune serum. Inoculation of the virus into 12 laying pullets caused a mild respiratory infection and a complete cessation of egg production in 4 of them for a period of 6 weeks, a 30 per cent. drop in egg production in another 4, but no effect on the remaining 4. The shell texture of the eggs laid by the infected hens was apparently normal but the albumin was watery. The respiratory symptoms cleared up in 1 to2 weeks in all the pullets except one, in which the respiratory symptoms became chronic. Severe coryza, gasping and râles were noted in this pullet until she died 2 months later. *Post-mortem* examination revealed cheesy exudate in sinus, trachea and thoracic air sac—typical of C.R.D. This illustrates how occasional birds with secondary bacterial complication following an outbreak of infectious bronchitis or other virus infections can resemble cases of C.R.D.

From all this information it was clear that the outbreak was primarily one of infectious bronchitis. The infection had probably persisted in the brooding plant by repeated passage from one batch of chicks to the next. The extremely mild nature of the infection in the chicks might be due to the fact that most of these chicks were hatched from eggs from recovered hens and were therefore likely to have a considerable degree of maternal immunity. As a result of this, some chicks might escape infection or show very mild symptoms in the brooder. Some of these chicks would have only a rather low immunity and would be vulnerable to fresh infection when they were put into deep litter houses as pullets. This might account for the outbreaks that occurred in some of the deep litter houses, and batteries, usually soon after several batches of pullets had been mixed together. The virus which set up the fresh infection could easily have been transmitted from the adjoining brooding plant, although it could also be carried by a few of the pullets.

It is important to note that in this outbreak, our attention was attracted mainly to the more obvious respiratory syndrome and the severe drop in egg production shown by the pullets in the deep litter houses, but the criminal virus which set the deep litter houses on fire was no longer there; and while our efforts were concentrated on putting out the fire, the bulk of the viruses were instead living happily with the chicks in the brooder houses. This shows how easy it is to misdirect one's control measures. In this case the owner had mistakenly concentrated his attention on the clinically affected pullets, ignoring the source of infection in the brooders.

In view of our findings, the owner was advised to suspend hatching for 2 months to break the cycle of infection and to enable a thorough cleaning and disinfection of the brooder units. These measures were taken in the autumn of 1957, and appeared to be effective, in that no respiratory trouble was noted in the flock during the 1958 season.

Outbreak Number 2

A big breeding flock, supplying day-old chicks and growing pullets.

The farm is rather a long way from Cambridge, and has not been visited by the writer. The history supplied by the owner was rather incomplete. He stated that at the early stage of the outbreak the birds seemed to be gasping for breath, later the eyes began to run and later still the eyes became sealed with mucus. In some cases the eyes became clear again, but gasping continued until death. Some birds were sent to near-by laboratories for examination. Reports showed that all the birds had tracheitis, but haemorrhage was found only in specimens sent at the later stage of the outbreak. A hen and a batch of chicks were sent to us. *Post-mortem* examination showed a fibrinous tracheitis in the hen. The nose, sinuses, eyes, lungs and air sacs were not involved. All the growers, however, had a severe involvement of the eyes. The eyelids were stuck together as a result of mucoid discharge, the conjunctiva was congested and highly inflamed. A pseudo-membranous tracheitis with cheesy casts was found in some of the birds, but no haemorrhage was noted. Nasal discharge and sinusitis was noted in one of the birds. P.P.L.O.

were isolated from the tracheal exudate of the infected birds but coccobacilliform bodies were not found in stained smears. An HI test was negative for Newcastle disease and a serum neutralisation test was negative for infectious bronchitis.

Exudate from the eyes and from the trachea of both the hen and the growers were inoculated separately on to the chorioallantoic membrane of 12-day embryonated eggs. Pock lesions were noted on all the membranes 3 days following inoculation. These lesions could have been produced either by I.L.T. or by fowl pox viruses, but the virus was shown to be I.L.T. by the demonstration of intranuclear inclusion bodies in sections of the infected membranes. Furthermore, experimental chickens inoculated with suspensions of the infected membrane into the trachea and on the comb showed tracheitis but no pox lesions on the comb. The result of the laboratory investigation showed that the outbreak was a case of infectious laryngotracheitis.

The infection has since spread throughout the whole flock with increasing severity. The mortality reached over 40 per cent. and most of the dead birds showed severe haemorrhagic tracheitis characteristic of I.L.T.

Large numbers of birds had been sold from this flock in the early stages of the outbreak when the disease was less obvious. Outbreaks were reported from most of the flocks which bought these birds.

We happened to follow an outbreak in a farm near Cambridge which obtained a batch of growers from the above farm some 200 miles away. These birds developed symptoms a day or two after arrival and the infection soon spread to the other birds kept on the farm including some three-week-old chicks, in which it caused a heavy mortality. A *post-mortem* examination was made on 20 dead chicks, 3 and 7 weeks old. Eight had haemorrhagic tracheitis typical of I.L.T. but 12 showed only a mucoid or cheesy exudate in the trachea. Pneumonia was noted in 6 birds, slight thickening of the air sac in one bird and eye lesions in 9 birds. I.L.T. virus was isolated from these birds as were non-pathogenic P.P.L.O.

I quote this case to show that the big breeding or supplying farms hold the key position in the control of respiratory disease or other infections. The most important task, in our effort to combat the various respiratory diseases, is to help the breeder to prevent and control them.

Outbreak Number 3

This farm consisted of a breeding stock kept in small breeding pens. There was a battery unit for 640 birds for egg production, a broiler house and a small hatchery and brooding unit. The growers were reared at range.

An endemic "cold" appeared in the flock every year. A similar outbreak started in the battery in September 1957, with symptoms of coryza and a marked and steady fall in egg production. The egg production in August and September was consistently between 65 and 70 per cent. The drop in egg production commenced in early October. By the middle of October it was down to about 50 per cent. with a steady fall to 35 per cent. at the end of the month. Chlortetracycline was given in the feed at a level of 75 g. per ton for the first 3 weeks and continued at half this level. There was a marked but partial response in egg production in the initial stage of the treatment, but production did not rise to anywhere near the previous level and fell again when the antibiotic level was halved. At this stage 2 birds were sent to the author for examination. The birds showed symptoms of coryza and gasping. *Post-mortem* examination revealed the presence of mucoid rhinitis, sinusitis and tracheitis. The air sacs were not involved. Coccobacilliform bodies were demonstrated in smears of both sinus and tracheal exudate. The organisms, together with some non-pathogenic P.P.L.O. were grown on P.P.L.O. media. Egg inoculation failed to isolate infectious bronchitis, I.L.T. or pox viruses. Serum neutralisation test showed the absence of antibodies against infectious bronchitis. Newcastle disease had, of course, already been ruled out by HI test.

From the above results the outbreak was diagnosed as uncomplicated chronic respiratory disease or Nelson's coccobacilliform coryza.

In a further enquiry it was interesting to find that the outbreak in the battery occurred about 2 weeks after a dozen of last year's hens were put into some spare cages. The infection was apparently introduced by these hens, as they had had a similar trouble in the previous year and some of them were likely to remain carriers of the infection despite apparent recovery.

After a thorough checking of the birds in the range, the brooding house, the broiler house and other parts of the farm, the infection was found to be confined to the battery. As it was not possible to dispose of all the pullets in the battery, nor of the breeding stock which had had the infection the previous year, the farm manager was advised to make a severe culling of these birds to eliminate those which were still showing obvious respiratory symptoms or which were in poor condition, in order to reduce the source of infection. Furthermore, attempts were made to keep the recovered birds in the batteries and the breeding pens as a separate unit under the care of a separate attendant, and to reduce the traffic between the infected units and the rest of the farm to the minimum. A close watch was kept on the newly hatched chicks to check for egg transmission.

So far these precautions have succeeded in preventing the infection from spreading to other parts of the farm and a healthy batch of young stock has now been raised to replace the infected birds.

This example will serve to show that an outbreak of C.R.D. or infectious coryza uncomplicated by other virus infections is not as infectious as infectious bronchitis or Newcastle disease and that it should not be too difficult to keep the infection under control provided that the outbreak is detected at the early stage before it has already spread to the whole flock.

Conclusion and Summary

The most important respiratory diseases of fowls, apart from Newcastle disease, are infectious bronchitis, infectious laryngotracheitis and chronic respiratory disease of chickens (including Nelson's coccobacillary coryza). Those of turkeys are infectious sinusitis and aspergillosis.

Table V summarises the clinical and epidemiological features which may aid the differentiation of these diseases and the laboratory methods which are used for the identification of their causative agents.

In my opinion, the most important step in the differential diagnosis of respiratory diseases is to determine whether any of the virus infections are present. This has to depend either on the isolation of the viruses or on the identification of antibodies, because many of these diseases often occur in a mild or atypical form without obvious or characteristic symptoms or lesions.

In an outbreak of chronic respiratory disease, it is important to know whether the outbreak is a chronic secondary complication following one of the virus infections or whether it represents the specific chronic respiratory disease of chickens, *i.e.*, an uncomplicated C.R.D. or Nelson's coccobacillary coryza. For the diagnosis of the latter, the direct microscopic demonstration and isolation of the pathogenic coccobacilliform bodies, using P.P.L.O. media or embryonated eggs, are more specific than the isolation of P.P.L.O. in general, because there are a lot of non-pathogenic P.P.L.O. inhabiting the respiratory tract of fowls, and they can be isolated from chickens with all kinds of respiratory diseases.

The various respiratory diseases differ in their epidemiology, thus, different emphasis is needed in their prevention and control.

The 3 major respiratory diseases, *i.e.*, infectious bronchitis, infectious laryngotracheitis and chronic respiratory diseases of chickens (including Nelson's coccobacillary coryza and infectious sinusitis of turkeys), together with Newcastle disease can be roughly divided into 2 epidemiological categories. Infectious bronchitis and Newcastle disease are highly contagious. In an outbreak, all the birds in the flock are often infected within a short period. Following the infection, the birds usually develop a good immunity and the disease will soon die out unless new batches of susceptible birds are continuously introduced into the flock, either by hatching or by new purchase. The recovered birds do not carry the viruses for more than a few weeks, but large amounts of viruses were eliminated by the birds during the active stage of the outbreak. Because of the high infectivity of these viruses, the infection built up in an outbreak may endanger new replacement of the flock and birds in the vicinity. Thus, in outbreaks where these two highly contagious diseases are suspected immediate steps must be taken to keep the flock in complete isolation during the active stage of the infection and to make a thorough cleaning and disinfection of the premises when the active infection is over, to prevent further spreading.

Infectious laryngotracheitis and C.R.D. represent the other epidemiological category. The main feature of these diseases is that some of the recovered birds may carry the infection for a long period. These diseases do not normally spread very rapidly, except in a densely populated farm where birds are in close contact. Severe outbreaks usually occur when several batches of birds are put together in big deep litter units or batteries, because any carriers introduced will have ample opportunity to transmit the infection to other birds and a fresh outbreak in a few birds is sufficient under the overcrowded conditions to provide an active source of infection for the rest of the flock. This is why C.R.D. and I.L.T. become more serious under the intensive system of production. The control of these diseases depends on breaking the cycle of the infection, ideally, by depopulation. If this is impracticable, the recovered birds, which may include many carriers, should be kept in isolation, and new replacements reared in another unit with separate utensils, feed and attendants. In any case, the recovered birds should be disposed of as soon as possible.

Finally, I would like to emphasise that a close collaboration between the field veterinarians and laboratory workers is indispensable in achieving the difficult task of making a speedy diagnosis in an outbreak of respiratory disease. Similarly, the effective prevention and the control of respiratory diseases require the effort of the poultry industry as a whole. The breeding and supplying farms have a specially important part to play.

Undoubtedly, the respiratory diseases will assume greater importance with the further development of the poultry industry. More positive measures must be taken for their control, otherwise it will soon be too late for effective action to be taken.

Acknowledgments.—I am greatly indebted to Messrs. William Trow and Frank Smith for their able technical assistance throughout the investigation, and to Mr. Alfred Tyrrel for rearing our experimental birds as well as looking after our C.R.D.-infected birds without any cross-infection over all these years. Without their valuable contribution this work would not have been possible.

I am also much indebted to Miss Audrey Newnham and Miss Maureen Butler for the active parts which they play in our joint enquiry into the mystery of "chicken's colds." The experience accumulated from our various research, though not directly concerned with diagnosis and control, is invaluable in the preparation of this paper.

My thanks are due to a large number of colleagues in the field and in other laboratories, especially Messrs. J. D. Blaxland of Weybridge, E. A. Gibson of the Veterinary Investigation Service, and Dr. R. F. Gordon of Houghton, for referring some interesting outbreaks to me and for their co-operation and help in some of the field investigation. The work is supported by a generous grant from the Agricultural Research Council.

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THE SPEAKER'S INTRODUCTION

Dr. H. P. Chu thanked the Association for having afforded him the opportunity of presenting his paper, and of discussing one of the problems in which he had been interested for some time. He apologised for the delay in getting the paper ready—a good excuse was his difficulty in finding the right English words!

A diagram on the first page of the paper was rather confusing in its present form. The reason was that the original photograph was in colour which separated the diseases into groups. *(The diagram in its original form was then shown as a slide.)* It would be seen that there were at least 12 respiratory diseases caused by different agents; those diseases were usually very confusing clinically, but aetiologically they could be classified into 4 groups.

The first group contained diseases due to faulty feeding and management, which were not unfamiliar. The second group contained bacterial, fungal, and helminth infections for which there were well-defined methods of diagnosis. The main problem in the differential diagnosis of respiratory diseases concerned the various virus infections included in the third group and the chronic respiratory diseases in the fourth group. Fortunately, with the aid of embryonated eggs, the various viruses could be grown and identified. The aetiology of the various chronic respiratory diseases was still rather confusing. When they were first described they were supposed to be different diseases due to different organisms, including viruses, but they were now believed to be the same disease due to pleuropneumonia-like organisms. The diagram shown summed up the problem of diagnosis. The differentiation between various virus infections and the so-called chronic respiratory diseases of chickens was stressed, because outbreaks of these virus infections with secondary complications often appeared clinically like chronic respiratory diseases of chickens.

Among the various respiratory diseases the most important ones were infectious laryngotracheitis, infectious bronchitis, Newcastle disease, and chronic respiratory disease. Clinically the 4 diseases could be divided into 2 categories, according to which section of the respiratory tract was most affected, the upper or the lower region.

On epidemiological grounds the disease could also be divided into 2 categories, and that was important because for the control of the diseases it was necessary to know about the epidemiology. Infectious bronchitis and Newcastle disease spread very rapidly but fortunately the birds which recovered possessed a high immunity and did not carry the virus for more than a month. Infectious laryngotracheitis and chronic respiratory disease, on the other hand, were not so highly contagious and did not spread so rapidly except in close contact, but some of the birds which recovered might remain carriers of the infection for a long time. In the early days when chickens were kept in small groups and in isolation, infectious laryngotracheitis and chronic respiratory disease were not so serious, but with the introduction of the intensive system these less contagious diseases could also spread very quickly. That was why contagious respiratory disease and to a certain extent infectious laryngotracheitis could become more and more serious as the industry grew in an intensive way.

From the epidemiological features mentioned above it was obvious that the key to the control of chronic respiratory disease and infectious laryngotracheitis was to get rid of the carrier. In the case of Newcastle disease and infectious bronchitis the most important control measure was to prevent the rapid spreading of the infection at the active stage of the outbreak. To achieve this, the detection of an outbreak and a diagnosis had to be made as quickly as possible if the disease were to be kept under control. Here the farm manager and the field veterinarians had the most important part to play.

(The methods used in the laboratory for the diagnosis of respiratory disease were then illustrated by a series of colour slides.) Exudate from infected birds was used for the isolation of causal agents. To detect the antibody there was the HI test for Newcastle disease and the Serum Neutralisation test for infectious bronchitis and infectious laryngotracheitis.

The confusion of the so-called chronic respiratory disease was illustrated by a slide which showed the organisms identified in 10 outbreaks of chronic respiratory diseases of chickens from which pleuropneumonia-like organisms had been isolated. Only 4 of these outbreaks were found to be true chronic respiratory disease or Nelson's coryza due to coccobacilliform bodies or pathogenic pleuropneumonia-like organisms. The rest were identified as primarily infectious bronchitis or infectious laryngotracheitis by virus isolation.

As far as one could see, in this country respiratory diseases were increasing but were still under control. In any event, the situation was not to be compared with that existing in the United States and many other countries. The author emphasised that it was necessary to decide which policy should be adopted for the control of infectious bronchitis, infectious laryngotracheitis, and chronic respiratory disease, and to act promptly.

The methods for the control of respiratory diseases were summed up in another slide. There were two choices.

One was the use of vaccination and chemotherapy as in America and Canada. The other was to aim at eradication of the disease or a means of keeping it in check by good management, sanitation, quarantine measures, or a slaughter policy. Chemotherapy could be useful in checking primary or secondary bacterial infections but no effective drugs were yet available for most of the primary causal agents including that of chronic respiratory disease. With the latter, various antibodies might reduce the disease clinically but did not seem to be able to clear up pleuropneumonia-like organisms.

The author emphasised that in order to get a speedy diagnosis and timely control of the spread of respiratory diseases, it was necessary to have close collaboration between the field and the laboratory, and it was also necessary to get the chick producers to take an active interest in the control of diseases.

The Opener

Dr. F. T. W. Jordan, who opened the discussion, said that the author had given a comprehensive list of the diseases which might affect the respiratory tract, and had emphasised that those which gave the greatest difficulty, both in diagnosis and control, apart from Newcastle disease, were infectious bronchitis, infectious laryngotracheitis, and chronic respiratory disease. It would be noted that all the diseases were named according to their aetiological agent except for chronic respiratory disease, which was a disease affecting any part of the respiratory tract and of a chronic nature, but the aetiology of which was as yet imperfectly understood. It had been suggested that the disease might be initiated by a variety of organisms, perhaps the chief of which was a pathogenic pleuropneumonia-like organism (the coccobacillus of Nelson), although some workers had found a virus (Fahey & Crawley, 1954). Occasionally the disease appeared to follow infectious laryngotracheitis and infectious bronchitis. The disease process appeared to be continued by secondary invaders, and there was evidence that some strains of *E. coli* might play a significant part in that rôle (Gross, 1958). There was still much work to be done in elucidating the pathogenesis of chronic respiratory disease.

He agreed with the author that field observations on a flock basis together with the *post-mortem* findings could be helpful in indicating the type of respiratory disease. It was important to point out that those observations must not only include respiratory symptoms, but also other possible symptoms—the rate of spread and duration of infection, morbidity, mortality, and the influence of the disease on growth and production. Even then Dr. Jordan felt that such observations were of limited value in arriving at an exact diagnosis. Perhaps that was to be expected, particularly when the variety of different factors which might be operating under field conditions was considered, for example, variation in virulence of the organism, breed and age of chicken, type of management, the possibility of multiple infections, and so on.

Respiratory symptoms alone he had found confusing and only recently had investigated an outbreak of infectious laryngotracheitis in which the chief symptoms and those which attracted the owner's attention were conjunctivitis and nasal exudate. There was no mortality. That might well have been confused clinically with haemophilus coryza or early chronic respiratory disease.

The location of initial respiratory symptoms, too, he had found quite variable and had noted in infectious laryngotracheitis, for instance, that symptoms might first appear as coryza, or as symptoms indicating a disease of the lower respiratory tract, such as rales and gasping respiration. On the other hand, some respiratory symptoms were quite helpful. For instance, the coughing up of blood he believed to be specific for peracute infectious laryngotracheitis, and he had noticed that aspergillosis both in turkeys and chickens occurred with gasping respiration without rales or any sign of coryza.

Apart from respiratory symptoms, other symptoms of value which might occur concomitantly were foul green diarrhoea, the indiscriminate laying of soft-shelled eggs, and nervous symptoms, all of which might be seen in Newcastle disease.

With regard to lesions, Dr. Jordan agreed that diphtheritic tracheitis was often suggestive of infectious laryngotracheitis, but it was not an invariable finding in that condition and might be simulated sometimes by chronic respiratory disease. Cream coloured, plaque-like lesions in the air sacs, especially if green hyphae were present, was seen in aspergillosis, although the lungs in those cases might contain numerous spherical nodules in no way resembling plaque-like lesions. It was found that avitaminosis A occurred sometimes without oesophageal lesions. He had observed that in field material and at the *post-mortem* examination of fowls which were kept experimentally on a vitamin A deficient diet by Professor Morton and his colleagues at Liverpool.

To augment some of the details given in the paper on laboratory diagnosis, when a fowl with respiratory disease was to be sent for *post-mortem* examination but had first to be killed, Dr. Jordan strongly recommended that it was not done by dislocation of the cervical vertebrae. By that means excessive haemorrhage occurred, and blood was often found in the mouth and trachea, obscuring the *post-mortem* picture. Such a blood clot in the trachea had given rise to an occasional false diagnosis of peracute infectious laryngotracheitis. Nembutal intravenously or chloroform (0.5 c.c.) into the brain through the foramen magnum were satisfactory methods of euthanasia.

If portions of the respiratory tract, for example, the trachea, lungs, or air sacs were to be sent to a laboratory for examination, they should preferably be sent in sterile screw-capped bottles. Such material he had found quite satisfactory for isolation of the virus of infectious laryngotracheitis.

With regard to the organs and tissues from which the virus of infectious laryngotracheitis was best isolated, it had been found that in the living bird it was advisable to swab from both the trachea and conjunctiva, and in the carcase material should be taken from the lung, trachea, and air sacs when lesions were present.

When material had been contaminated with regurgitated crop contents, or *post-mortem* changes were occurring, Dr. Jordan had frequently found that penicillin and streptomycin even in much greater concentration than that recommended by the author did not prevent bacterial growth and death of embryos. In those cases it was found that filtration of material through a bacterial cellulose acetate filter was effective in retaining the bacteria while allowing virus to pass. Fungi, which were occasionally present in material to be examined and which were sometimes responsible for death of embryos or the production of lesions similar to infectious laryngotracheitis, might also be removed by that method of filtration.

The author's suggestions for control were very interesting. He had depicted the poultry industry in terms of the supplying farms, the hatcheries, and the commercial egg or meat producers. He had said that supply farms for hatcheries were few and large. Whilst that was true for some hatcheries, it was not true for the majority for which there were numerous supply farms, some of which were comparatively small. For instance, some of the larger hatcheries had supply farms throughout the country to provide them with the vast numbers of eggs they required and as an insurance against Newcastle disease. The great bulk of the hatchery trade involved the purchase of eggs from the supply farms and the sale of day-old chicks to the commercial farms. Dr. Jordan suggested, therefore, that only those respiratory diseases which were egg-borne would be of significance in the transmission of respiratory infection from the supply farm to the commercial producer. More exact information about egg transmission of respiratory disease was required, but it would appear that chronic respiratory disease was the most likely one to be transmitted in that way, and it was perhaps then the exception rather than the rule. It would be interesting to have the author's opinion on that.

Dr. Jordan's experience with chronic respiratory disease on supply farms indicated that the progeny even when hatched on the supplier's premises but delivered to commercial farms as day-old chicks showed no evidence of chronic respiratory disease, and when they did it was usually associated with their mixing with recovered adult stock on the premises of the commercial farm.

If he interpreted the author's suggestions correctly, it was a little difficult to see that the reduction of infection

on supply farms was the most important single step in the eradication of respiratory disease except for egg-borne infections. With other suggestions for control Dr. Jordan found himself in full agreement, and in particular he believed that the rearing of young stock in isolation, avoiding direct or indirect contact with birds of different age groups and different sources, was invaluable except in the control of the more highly infectious conditions such as Newcastle disease and infectious bronchitis.

The possibility of a nation-wide assessment of respiratory disease was intriguing, but one wondered whether it was a practicable proposition with present methods of diagnosis which were complex, time consuming, and expensive in materials. Further, there were few diagnostic laboratories with facilities adequate for such work. However, Dr. Jordan suggested that there was need to learn much more about the epidemiology of the various respiratory diseases, especially their modes of transmission, and that efforts should be made to find simpler methods of diagnosis.

He asked the author for his evidence that Newcastle disease and infectious bronchitis automatically died out in a flock. Dr. Jordan had made no personal observations, but his interpretation of the literature was that there was conflicting evidence as to the existence of the carrier state in those diseases.

The author's attempt to produce a dead vaccine against infectious laryngotracheitis was interesting. Dr. Jordan had found that the condition appeared to be satisfactorily cleared up on isolated farms if the farmers were prepared to depopulate, disinfect, and restock after leaving the premises empty for a month. That method was unsatisfactory, however, if the farm were small and contiguous with other infected premises such as were seen in parts of Lancashire. On those farms trials were being conducted with autogenous vaccines.

The Reply

Dr. Chu, in reply, said that the question raised by Mr. Tweed on the practical measures for the control of field outbreaks was a very important one. He fully agreed that some of the suggestions mentioned in the paper might have practical difficulties under field conditions. For that reason, at the end of the paper he had described in a practical way how 3 field outbreaks, one of infectious bronchitis, one of chronic respiratory disease, and one of infectious laryngotracheitis were handled, how a diagnosis had been made and the method of control which had been suggested. It illustrated some of the problems and difficulties under field conditions.

In reply to Dr. Jordan about supply farms, in one place it applied to supply farms which produced eggs for hatching, but in another place it referred to supply farms which provided chicks and growers. The outbreak of infectious laryngotracheitis mentioned above occurred on one such supply farm which sold chicks of up to 8 weeks by auction, and before infectious laryngotracheitis was diagnosed, a number of batches of chicks had been sold all over the country. Prevention of disease on these farms was obviously very important in the control not only of egg-transmitted diseases but of most respiratory infections.

Egg transmission was a potential problem, and among the diseases in which egg transmission was most suggestive was chronic respiratory disease. Very good work had been done by a number of people in the United States and Canada where it had been shown that the chronic respiratory disease agent could be readily identified in dead-in-shell chicks from infected eggs, and chicks hatched from those eggs could sometimes carry the organism. More recent work by van Rockel had, however, shown that flocks free from the disease have been raised with eggs from infected birds. The author had not much experience in that connexion because he was rather handicapped by lack of facilities for keeping large numbers of chicks for a long period, but during the last few years he had had an opportunity of investigating a big outbreak of chronic respiratory disease in Egypt.

He found 9 farms carrying 10,000 breeding stock which had chronic respiratory disease. After severe culling, about 3,000 hens in good condition were put into 2 farms, and the other 7 farms were emptied for some 3 months while waiting for the hens to have a complete recovery. Then 10,000 eggs in 4 batches were sent to 2 of the farms and a close watch was kept on every batch of chicks. Chicks were examined every 2 weeks for respiratory symptoms. Every chicken which died had a *post-mortem* examination. In 6 months when they were in full production, 10 per cent. of the cockerels were killed to see whether they had any disease but they were all free from respiratory lesions. These 2 farms had remained free from any respiratory diseases during the last 3 seasons. These encouraging results seemed to suggest that in certain outbreaks of chronic respiratory disease egg transmission was not as serious as one thought.

In his view, for the control of respiratory diseases, the choice was not necessarily between an all-out vaccination programme and a slaughter policy. There was some intermediate method. The choice depended on the incidence of the disease in the country. In the case of Newcastle disease, which was rare, the slaughter policy was practicable but if it were found that bronchitis, infectious laryngotracheitis, or chronic respiratory disease were widespread, mass vaccination using living virus was not the only alternative. Isolation and disposal of infected birds and rearing replacements away from the infected flock, together with the use of killed vaccine in certain cases, were practical measures. The fact that chicks could be reared in complete isolation from adult stock should make disease control much simpler.

With regard to mass vaccination using living virus, the method was not as simple as one imagined. A vaccine which worked nicely in the laboratory might not always be satisfactory under field conditions. One of the main difficulties was the adjustment of the virulence of a vaccine to meet a wide range of birds in the field which might vary greatly in their immunity status. The author was interested in the advice given by our Canadian colleague, Dr. Avery, that this country would do well if it could manage to keep away from the living virus vaccine.

Similarly, chemotherapy was not as simple as one hoped it might be. About 5 years ago, when he advised the injection of streptomycin in outbreaks of chronic respiratory disease, 9 cases out of 10 responded to the treatment. If the same thing was done to-day probably only 5 out of 10 cases would respond due to the emergence of resistant strains.

In answering Mr. Bandaranaike on Newcastle disease vaccine the author mentioned that from his experience in Egypt the Komarov strain seemed to be very satisfactory, but it was necessary to adjust the dose of the virus to suit the particular age group. The vaccine, however, was generally used for chicks over 6 weeks of age. In his view the differentiation of vitamin A deficiency and fowl pox was not difficult. In vitamin A deficiency, the coryza syndrome in some birds was accompanied by the presence of nodules on the oesophagus and the deposition of urates in the kidneys. Fowl pox could be readily diagnosed by virus isolation using embryonated eggs.

In answering the question raised by Dr. Brown on the rôle of *Escherichia coli* in the aetiology of chronic respiratory disease the author said that *E. coli* was certainly one of the commonest bacteria which could be isolated from the air sacs in outbreaks of chronic respiratory disease. Some strains were shown to be able to cause septicaemia in chicks. The infected chicks might show pericarditis and peritonitis similar to those seen in some outbreaks of chronic respiratory disease. Gross (1958) showed that chicks exposed to pleuropneumonia-like organisms were more susceptible to *Escherichia coli* infection.

Regarding the problem of carriers following the various respiratory infections it was well known that chronic carriers were common in infectious laryngotracheitis and chronic respiratory disease. In the cause of infectious bronchitis, according to published work, the birds which recovered did not carry the virus for more than a month.

With regard to the practicability of such an elaborate diagnostic method for general use, he did not suggest that it could be applied to every individual bird; but, as was emphasised in the paper, the control of poultry disease had to take the form of control of diseases in the flock as a whole. With a combined effort of the field and the laboratory worker and active collaboration from the farm managers the task might not be as difficult as it appeared.

Mycotic Dermatitis in Great Britain 1954-58

BY

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Introduction

THE recognition of mycotic dermatitis (lumpy wool) of sheep was made almost simultaneously in South Africa and Australia by Bekker (1928) and Seddon (1929) respectively. These authors described almost identical lesions affecting the woolled and hairy parts of the body but it was Bull (1929) who first isolated, recognised and named the causal organism as an aerobic actinomycete called by him *Actinomyces dermatonomus*. Full details of the clinical and laboratory aspects of the disease in these two countries may be found in these papers and more recently they have been revised by Seddon (1953).

In Britain no published record of the disease was made until Nisbet and Bannatyne (1955) described outbreaks affecting the haired parts of the body of Scottish Blackface hill sheep in Argyllshire. Soon after this account Kane, Downing and Wilsdon (1955) briefly reported the occurrence of the typical wool condition but subsequently there has been only one report (*Annual Report of the Animal Health Service of the Ministry of Agriculture for 1956, p. 49*). There is now, however, much evidence that the disease has been known for a great many years but has never before been considered of economic importance.

Our observations were begun in 1954 and have been continued intermittently with the help of members of the Veterinary Investigation Service and others without whose assistance the following account could not have been prepared. We deal firstly with the causal organism of mycotic dermatitis and then with the records of the disease obtained during routine diagnostic study and by the examination of affected flocks. There follow accounts of the clinical appearance of affected animals the laboratory diagnosis, the isolation of the organism and the methods we have employed in the field investigation of the disease. The present and possible future economic importance of the disease has also been considered.

The Causal Organism

Mycotic dermatitis is caused by the aerobic actinomycete *Dermatophilus dermatonomus* and the historical background to the disease has recently been reviewed by Austwick (1958) who considered that this name was the only valid one for the organism. In this paper the organism described by Van Saceghem in 1915 as the cause of cutaneous streptothricosis in cattle—*Dermatophilus congolensis* was taken as the type of the genus and the close relationship between this species and *D. dermatonomus* was pointed out. The genus Dermatophilus is characterised by the longitudinal and transverse division of the fine branching filaments, a property quite unlike that of any other actinomycete (Fig. 1). These divisions occur some distance behind the growing tip of the filament and are first closely spaced transversely, later becoming longitudinal in several planes so that the filaments consist of rows of compartments. Each of these gives rise to a motile flagellate coccus which swims away and eventually germinates to form another filament. Development takes about three days at 37° to reach the motile coccus stage and the whole of the filament is generally dissociated into cocci after 6 days.

Mycotic Dermatitis in Great Britain

Our attention was directed to the occurrence of skin lesions in sheep in this country late in 1954, following a study of material from South Africa, Australia and South America (Ainsworth & Austwick, 1954). The following Table shows the number of specimens (counted as one per flock) received at Weybridge for examination from Veterinary Investigation Centres, the British Wool Marketing Board and other sources from 1955 to 1958.

TABLE I (EXCLUDING RESULTS OF SURVEY)

	Field samples from V.I. Centres	Wool samples from B.W.M.B. etc.	Positive diagnosis	% +ve	Total
1955	5	5	8	80.0	10
1956	4	24	8	28.5	28
1957	17	2	10	32.6	19
1958 to Aug. 31st	35	6	37	84.7	41
	61	37	63		98

Although these figures are not adequate for detailed analysis they indicate the change in the sources of material which has occurred over the 4 years. The 1955 figures are related to the occurrence of widespread outbreaks of mycotic dermatitis in the summer of that year which were brought to our notice by veterinary surgeons and farmers. No further serious outbreaks occurred in 1955 and the condition only caused concern when the 1956 wool clip was graded, hence the large number of samples forwarded through the British Wool Marketing Board in that year. A number of severe outbreaks

occurred during the late summer of 1957 and further attacks occurred until after shearing in 1958 when a flare-up comparable with 1955 took place. The emphasis has thus now turned to the field and increasing numbers of outbreaks have again been reported by Veterinary Investigation Officers.

Since September, 1957, some 44 flocks of sheep have been visited and 1,291 ewes and 784 lambs examined individually for the disease. These figures include a survey of 33 farms made in one area and the total number of sheep in the flocks examined was about 6,000. The average infection rates for the ewes was 78.6 per cent. and for the lambs 70.9 per cent. The lowest in any flock was 20 per cent. (Scottish Blackface cross) and in 7 flocks all the ewes were infected. The owners of 30 flocks visited during the survey were not aware of the existence of the disease despite the high infection rate, for the chief clinical sign noted was loss of wool and this occurred in only some 4.5 per cent. of all the sheep examined.

Infected flocks have been found in 28 counties of England, Scotland and Wales and in the Isle of Man and although there is a concentration in the Western areas severe outbreaks have also occurred in North East Scotland and on the East Coast.

Details of the breeds affected are only available in 35 of the 96 affected flocks but these are given in the following Table:—

TABLE II

Clun and Clun cross ...	22
Cheviot and Cheviot cross	6
Suffolk	3
Hampshire Down	1
Scottish Blackface	1
Romney	1
Welsh cross	1
Total:	35

These clearly show that most of the reports have been from the fine woolled breeds although there seemed to be few differences in the infection rates of any of the flocks examined whatever the breed.

Clinical Features

Examinations of affected flocks have been made at all times of the year and under many different weather conditions and our knowledge of the clinical appearance of the disease has been continually widened with increasing numbers of animals examined. Frequently the majority, if not all of the sheep, presented a normal appearance and the most noticeable features were the scabby lesions on the ears and nose, particularly in the lambs (Fig. 2). Loss of wool was rarely seen although it was frequently the reason for attention being directed to the sheep (Fig. 3). On a few occasions intense pruritus was observed but this was apparently only a transient phase. The irritation had caused the animals to rub under fences and sometimes to gnaw at their flanks producing raw, profusely bleeding areas.

In order, however, to understand the variation in the clinical appearance of the disease in the field it is necessary to outline the experimental infection cycle, for this holds the key to the clinical appearance of the field condition. Infection can apparently only occur on damaged skin, and when a six-day-old culture or a suspension of field material is rubbed on to a plucked or scarified area on the back of a sheep marked erythema appears within 48 hours, followed by the formation of 1 to 2 mm. diameter papules which develop cream-coloured centres by 3 days. During the subsequent 3 days these pustules dry, harden, and together with much exuded serum and desquamated epithelial cells, form a hard buff-coloured or white scab 1 to 2 mm. thick on the surface of the skin. By the seventh day after inoculation the scab becomes loose from the skin and is subsequently carried up by the growth of the wool to be left as a zone corresponding to the date of the attack (Fig. 4). All lesions, no matter where they be situated, seem to follow this cycle, but on some occasions the scab persists and continues to thicken for several months, whilst on others it may drop off on the seventh day.

Basically the lesion is a pustular and exudative dermatitis which is followed by scab formation. Although the pustules are the characteristic feature of the initial infection they are rarely seen except on areas of almost bare skin such as in the axillae, in the inguinal region or on the udder.

Lesions on Ewes and Rams

Woolled Areas

Except for short periods after shearing the external appearance of the affected animals has often not shown any signs of the disease but experience has frequently enabled us to pick out the sheep which have hidden zones of scabs in the wool or active lesions on the skin. In general, striking whiteness and dry appearance of the fleece was a useful guide, whilst derangement of the wool along the back and down the flanks frequently indicated lesions beneath the surface.

On parting the wool, single and multiple zones of scabs could be seen varying in colour from white nearest the skin, to buff, orange, brown or black towards the tips of the staple according to the date on which the scabs were formed, and the appearance of these scabs varied considerably with the wetness of the fleece. The size of the affected areas varied from small scattered foci to large extensive areas at times involving the whole of the back and flanks. Moreover, observations on experimental infections have shown that individual lesions spread peripherally in successive attacks so that all lesions progressively enlarge. Wool loss was not common and seemed to indicate a very severe attack followed by rapid drying of the scab. This caused contraction of the scab which then became concave beneath and apparently pulled out the embedded wool fibres from their follicles. The exact mechanism and cause of depilation is, however, unknown. Normal wool growth was usually resumed immediately, but in certain breeds, especially Suffolks and Clun Forest, the wool formed was generally pigmented for 2 or 3 months before the normal colour was

restored. Areas of recent wool loss were shiny, sometimes scaling or bleeding, and attractive to flies. Always surrounding such areas the wool had a zone of milder lesions which corresponded to the time of wool loss.

The feature characteristic of attacks which took place immediately after shearing was that the tips of the wool fibres were stuck together by the scabs and as the wool grew these agglutinated masses became weathered and colonised by saprophytic organisms. Among these was the pink yeast (*Rhodotorula* sp.) which was responsible for the "pink sheep" phenomenon seen in many areas in 1955. Other saprophytic fungi such as *Pullularia pullulans* have been found in the darker coloured agglutinates.

Haired Areas

A characteristic feature of infection was the presence of lesions in the haired areas of the body, such as face, nose, ears, chin and legs, as well as in the inguinal region and udder. On the ears the lesions consisted of hard discrete scabs with concave bases of up to 5 mm. in diameter on the surface and edges of the ear. These were easily shed and when removed often left intensive bleeding patches. Similar hard almost nodular lesions were seen on the nose, on which the early stages were detected by the "staring" of the hairs which later became embedded below in the serous exudate. The lesions on the legs were identical but often concentrated on the hind part of the hock and forearm extending up to the elbow or knee. Lesions on the udder, in the axillae and in the inguinal region were pustular but the scab appeared to be lost immediately on the completion of the 7 day infection cycle leaving a virtually intact skin.

Examinations Made During Current Attack

Examinations made between the second and fourth day of an attack showed the acute stages of the disease and in this the skin was hyperaemic, painful to touch and had scattered whitish pustules which were extremely difficult to see beneath the wool. The surface of the skin was soft and soapy with the exuding serum and epithelial debris. Removal of the pustules revealed their superficial nature and that this stage left a small 1 to 3 mm. in diameter, shallow, bleeding depression which, however, soon healed. The scabs still adherent after the seventh day also left raw and bleeding areas when removed and the existence of an active attack could be shown by removing one to show this feature.

Lambs

Lesions on the ears of lambs have been observed within 14 days of birth. The pinnae were at first diffusely hyperaemic, inflamed and oedematous with numerous papules covered by thin white scabs. Within a few days the inflammation subsided, the scabs began to thicken and in older lambs were up to 5 mm. thick often hanging round the edges of the ears. As the scabs peeled off the areas of skin uncovered were bald and later heavily pigmented. Scabs also occurred on the top of the nose and when removed also left bleeding points.

Lesions in other parts of the body have only been found on 13 of the 784 lambs examined. They were present on the top of the head and/or the neck in 8, and on the back in 5; only 3 had lost any wool, one down the back of the neck at the age of one month and two, both in the same flock, on the back at the age of 5 months.

From our limited observations of the disease in lambs we believe that sheep become infected on the face and ears as lambs, and that the disease spreads down to neck and on to the back. The position of the scabs in the wool indicated that the attacks occurred at the same time as extensive ones on the faces and ears of other lambs and also on the bodies of their mothers. The rarity of body infections in lambs under 5 months may indicate that a build-up of infection is required on an individual animal before severe body lesions can occur.

The lesions observed on the woolled parts of the body are thus identical with those seen by Australian and South African workers, whilst those on the face and ears are similar to those described by Nisbet and Bannatyne (1955) although we have not found lesions on the scrota of tups.

One of the difficulties in diagnosis has been the presence of severely encrusted lip lesions accompanied by oedema in a number of outbreaks. These resembled those attributed to contagious pustular dermatitis (Orf) and although Dermatophilus-like filaments were observed in the scabs, the possibility of virus infection must still be considered. More recent evidence tends to confirm that these lesions and those of strawberry foot-rot are identical and are caused by another closely related species *D. pedis* (Thompson, 1954; Austwick, 1958).

Laboratory Diagnosis

Direct Examination

In the wool the typical scab was light in colour when close to the skin but darkened with age. A great many attempts at diagnosis have led us to believe that the lighter the colour of the scab the more easy it is to find the diagnostic filaments of *D. dermatonomus*, for weathering soon leads to their dissociation into cocci. Selection of the right part of the scab or zone is thus of great importance, for the filaments are easily broken up and only represented by sarcina-like groups of cocci, which we are unable to consider as diagnostic at our present state of knowledge.

The standard method of laboratory examination was recommended by Mr. J. R. Hudson and consists of the preparation of a fixed smear from pieces of scab moistened for about 5 minutes with sterile saline or distilled water. A thick smear is made, preferably with another slide, dried, fixed in methyl alcohol and stained in 1 : 10 Giemsa's stain for 30 minutes. The resultant preparation is examined under oil immersion and the filaments are stained deep purple, the cocci similarly, leucocyte nuclei dark blue and the epithelial cells light blue. The filaments of the organism may be 2 to 5 μ wide,

divided into as many as 8 rows of cocci, and often being broken up into very short lengths. Occasional groups of very long divided filaments may be seen and in nose and ear scabs especially, the filaments are often only 1 μ wide, undivided, or with a single row of cocci. Such is the tendency of the filaments to dissociate when mature that it is rare to find their diagnostic features in scabs which are more than 1 cm. from the surface of the skin. Rapid staining of smears with 2 per cent. methylene blue has also proved satisfactory.

Isolation of Dermatophilus dermatonomus

Although a number of authors have accomplished the isolation of *D. dermatonomus* without difficulty from field material, this has not been our experience. The organism has frequently been seen in dried scabs in great quantity but despite many attempts it has only been isolated by us on two occasions. Isolates have also been obtained twice from scabs from experimental inoculation of field material. The method of isolation has been simply to grind up the scabs in sterile saline and streak out on to 5 per cent. bovine blood agar and incubate at 37° C. Colonies at 24 hours appeared as pin points surrounded by a narrow zone of β-haemolysis and after 3 to 4 days the colonies were 1 to 2 mm. in diameter heaped up, matt, whitish or pale yellow, usually becoming orange, particularly if left in the light. The microscopical appearance of the colonies followed the series of events already described for the individual filaments in the scab.

Estimation of Incidence of Infection in Flocks

Our preliminary experience in attempting to estimate the incidence of the disease in a flock showed the necessity for a standardised procedure for the examination of the sheep. Two methods were, therefore, devised to ensure that the maximum information was obtained from each flock examined. The first method consisted of the examination of an animal from nose to tail and down the flanks to the belly with reference to a chart of the surface of the animal which had previously been numbered according to the various anatomical areas. Each of these zones was searched systematically and the findings recorded in a Table. Notes were made of the existence of active or past attacks and the position of these in the wool. This method inevitably took a long time so that it was not always possible to use it, and the second method was therefore devised. This consisted of merely recording the presence or absence of lesions on the head and on the body with occasional notes on individual animals and we are indebted to Mr. N. H. Brooksbank for his help in this respect.

Most of the flocks contained between 100 and 200 sheep and generally 20 to 80 animals were taken for examination at random from the groups kept in the holding pens. Although this method is not as accurate as desired we believe that the figures obtained are reliable and in fact were occasionally rechecked with similar results.

Relation of Infection to Weather Conditions

A direct relation of mycotic dermatitis to rain has been recognised from the first but no precise figures are available for the amount of rain required to initiate an attack. We have not yet had the opportunity of correlating attacks of the disease with periods of rain but preliminary data were sufficiently encouraging to suggest that there was a very close relationship between outbreaks and the rainfall in each area when the latter reached above a certain critical amount and intensity.

Clearly if the organism is dependent upon rain damage to the skin, wetting must be considerable for certain minimum lengths of time to enable the germination of the motile cocci to take place. Once filaments have formed and are growing into the softened layers of the stratum corneum the intense reaction develops and the attack proceeds independent of the subsequent weather conditions.

It appears that at least 24 hours' continuous light rain, or a few hours of heavy rain, provide sufficient damage for this infection to take place and the more prolonged the periods of rain the more severe the infection. We have observed that naturally infected sheep showing active lesions which have been experimentally housed for 2 months, during which time the scab had lifted from the surface of the skin, when re-exposed to heavy rainfall on being turned out showed active lesions within a week.

Contributory Factors

Besides actual wetting of the fleece there are other factors which may contribute to outbreaks of mycotic dermatitis. We believe that among these pre-clip washing definitely favours an attack at shearing time, the washing usually being carried out the week before shearing, but at present we cannot produce conclusive evidence that this is so. We have also seen in the wool zones corresponding to the times of dipping but again are not prepared to correlate the two events. Shearing itself may possibly favour the development of the disease both by damaging the skin slightly and by providing admirable circumstances for the contact spread of the scab material in the wool from sheep to sheep (assuming that the disease is, in fact, contagious). Many sheep have been examined which showed no, or only slight, signs of infection before shearing but developed extensive lesions directly afterwards.

The Problem of Control

We have carried out two attempts at the control of the disease in the field but have found great difficulty in assessing our results, chiefly because each attack undergoes the 7-day disease cycle and spontaneous recovery of the skin often occurs after that time. Over a longer period the criterion of success must be the continued absence of any further scabs in the wool after treatment has been carried out.

One attempt at treatment was made in a flock of 58 pedigree Cluns. They were divided into 2 groups, examined in August and again one month later. Approximately 92 per cent. were affected before

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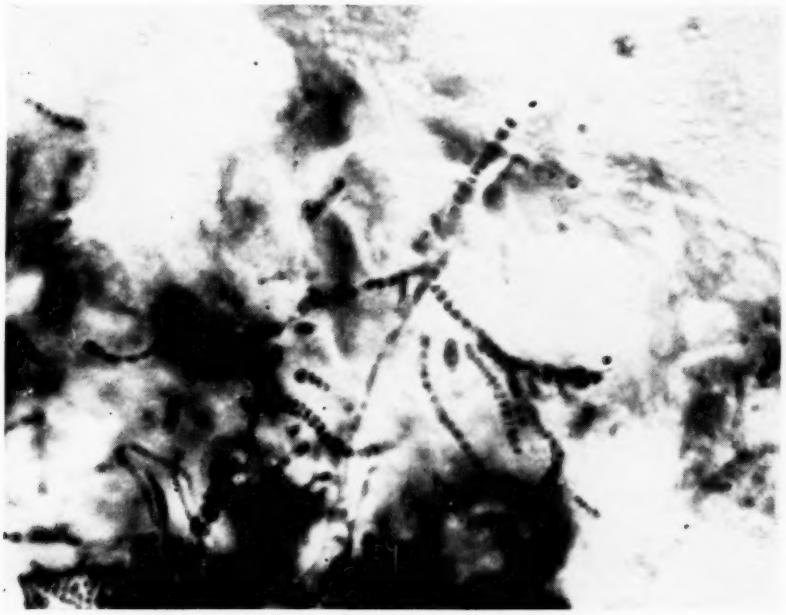

FIG. 1.—Divided filaments of *Dermatophilus dermatonomus* in a scab from Clun Forest lamb. Giemsa's stain. × 500.

FIG. 2.—Scabs from ear lesions. April, 1958. (a) to (c) from Suffolk lambs. (a) and (c) undersides showing concave surface. (d) section of scab from edge of ear of Cheviot lamb. (e) and (f) upper and undersides of scabs from Border Leicester ewe.

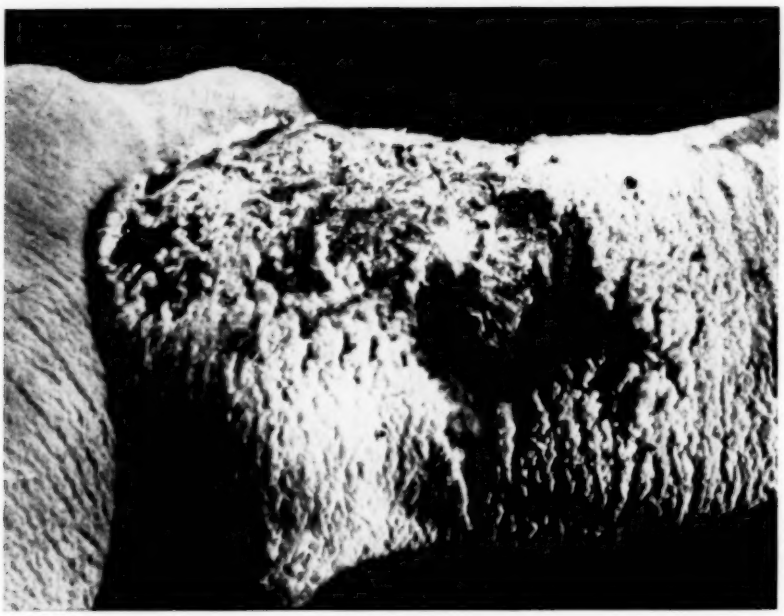

FIG. 3.—Clun Forest ewe. August, 1958. Wool loss following severe infection, showing black pigmentation of the skin and new wool growth.

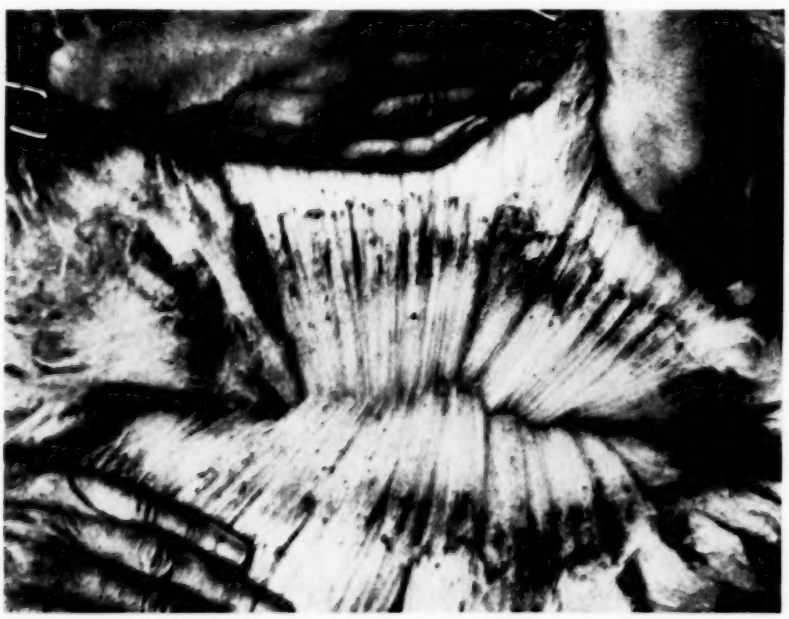

FIG. 4.—Cheviot ewe. June, 1958. Zones of dark scab representing attacks in September and November, 1957, with complete subsequent recovery.

dipping was carried out in late September. One group was dipped in a standard arsenical dip and the second in a proprietary preparation containing copper sulphate. In the following November they were examined again and there appeared not to be any differences between the two groups, but the overall infection rate was 80 per cent. Unfortunately during the winter a number of the ewes lost their ear tags and therefore a smaller number was available in May when our last examination was made. This time some of the ewes which had had active lesions in the autumn were now completely free and an overall infection rate of 60 per cent. was found. However, other ewes from both groups still had severe active lesions and evidence of attacks throughout the winter. The lambs were also examined and 72 per cent. were affected with scabs and pustules on the ears and nose but no lesions occurred in their woolled areas. Regrettably, we were unable to keep undipped controls in this experiment.

The other trial in pedigree Suffolks was carried out in co-operation with Mr. W. B. Shaw, A.V.I.O., at Newcastle and was more limited in scope. Only 4 of the original 8 treated animals were seen after 6 months. All these showed no further attacks after dipping in the same proprietary copper sulphate dip, with clean wool stretching from the infected zone to the clear skin. Two undipped controls kept here, however, showed precisely the same appearance, but in a single ewe which had been so severely infected in September that she had lost all the wool from the back, at least 3 further attacks occurred between the time of dipping (November) and March when she was slaughtered. One of the undipped tups on the farm which had only been infected on the nose in September and then showed no zones in the wool, was found to be severely infected in June, without any signs of attack during the previous year.

In still earlier attempts at control, both copper sulphate dipped and undipped animals likewise showed no further attacks of the disease after dipping in November, and the only effect that the treatment definitely had was the dispersion of the scabs on the tips of the staple in the course of 6 months.

Natural recovery in 7 days generally means that the scabs are ready to drop off at any time after this period. This means that ear and nose lesions may resolve by the loss of scabs and the growth of new hair in 2 to 3 weeks. In wool, however, the scabs are retained until shearing and remain as a source of infection. In any attempt at control it is clear that full consideration must be given to the life-cycle of the organism and the tendency for spontaneous recovery from the disease. The interpretation of any results must also take into account that natural recovery can occur in this very short period of time and may be permanent.

Economic Importance

It is perhaps unusual to include mention of economic importance, but we feel justified on this occasion in what is essentially a clinical and laboratory account.

Loss of wool and raw bleeding skin lesions have generally been the reason why owners have called in their veterinary surgeons, although a number have actually noted the declining value of their wool and on very rare occasions it seems possible that the disease may even have led to the death of a sheep. Although these events attract attention they are often of little financial importance. Scabs, on the other hand, may first be seen at shearing time and severely infected animals may cause considerable trouble in loss of time and temper and in the breakage of machines. However, the economic importance of mycotic dermatitis lies in the devaluation of the wool when it is graded. The effect of this devaluation is often not appreciated by the farmer until a comparison is made with the wool returns of previous years. In badly infected flocks the proportion of lower grade wool has been found to increase greatly in years following severe field outbreaks. Taking into consideration the apparent increase of the disease this year, we expect that in 1959 clips of fine wools will not be as good as in the previous 2 years.

The actual amount of loss of value of the wool depends on its quality, the greater losses occurring in the fine-woolled breeds. Here, assuming a maximum price for Grade 5 wool of 80 pence per pound, badly affected wool will drop as much as 15 pence per pound, representing a loss of 10 shillings or more on a fine fleece. Our estimates reveal that in any flock with a small number of severely infected animals the incidence of infection overall is likely to be at least 70 per cent. and so it is likely that although the maximum loss may only occur in a few fleeces many of the others are likely to be devalued.

Exact figures for wool devaluation due to mycotic dermatitis are not yet available and an attempt is being made to collect the necessary information by examining the wool returns from infected flocks. So far 5 sets of returns have been obtained but no detailed analyses have been made. However, one example of financial loss can be quoted concerning a Clun Forest flock apparently free from the disease in 1956 but severely infected in 1957 and 1958. The average price of the wool in 1956 was 74 pence per pound, but in 1957 and 1958 was 63 pence and 64 pence per pound respectively, which, allowing for the slight drop in fine wool prices (about 3d. per pound) still gives a decrease in the return from the same ewes of 12 per cent. It is realised that any analysis of wool return figures must be made with considerable care because of the large numbers of variable factors involved, not the least of which is that mycotic dermatitis is not the only cause of the devaluation of wool. If similar losses, however, occur in other flocks, it is obvious that the position can be serious for the individual owner and the assessment of the wool loss on a national basis is urgently required.

Acknowledgments.—As we have already stated, this account could not have been prepared without the assistance of the Veterinary Investigation Service of the Ministry of Agriculture, Fisheries and Food, the Isle of Man Board of Agriculture, the British Wool Marketing Board, and many veterinary surgeons in practice. In the Veterinary Investigation

Service, particularly, we would like to thank Mr. W. B. Shaw for arranging one of the dipping trials, and Messrs. M. Barr, N. H. Brooksbank, R. M. Loosmore, H. E. Roberts, P. L. Shanks, A. J. Stevens, T. F. Vallely, and J. A. J. Venn for arranging visits to flocks. Mr. E. A. McPherson, Royal (Dick) School of Veterinary Studies, and Mr. F. White, Rowett Research Institute, also kindly arranged visits. Mrs. J. D. Cartner gave unstinting help with the laboratory examinations. We are also grateful to Messrs. Robert Young of Glasgow who supplied the dip used in one trial. Lastly we can hardly express our thanks adequately to Dr. G. J. Kane for his continued help and encouragement throughout these investigations.

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THE SPEAKER'S INTRODUCTION

Mr. P. K. C. Austwick, in introducing the paper, said he hoped that he would be forgiven for any difficulty the audience might have in understanding his terminology for, as a botanist, his knowledge of animal disease was strictly limited. Mycotic dermatitis was a disease on which Mr. Davies and himself had been working sporadically for 4 years. He referred to the printed paper as a compilation of their experiences with the condition and then illustrated the morphology of *Dermatophilus dermatonomus* and its relationship to the disease cycle by diagrams of the development of the disease from the time of infection to the lifting of the scab.

He then showed a series of slides of the causal organism and the clinical appearance of the disease.

The Openers

Mr. G. B. S. Heath, in opening the discussion, said that he did not know a great deal about the condition and all he proposed to do was to speculate a little. He had just examined 12 lowland flocks fairly thoroughly to ascertain whether the disease was present. In 2 of them he was unable to find it; 8 flocks were lightly affected; the other 2 were very badly affected. In his opinion, 2 of the sheep he had seen should have been slaughtered on humanitarian grounds.

The disease could be very bad indeed and it was probably widely distributed. The authors had obviously done a very good job in drawing attention to the presence of the disease in sheep. One could not say with any degree of certainty when the disease first appeared. He had been familiar with the possibilities of lumpy wool occurring since the early 1940s and had looked for it. There was a condition which was probably due to excess activity of the sebaceous glands. Small lumps of wax appeared and the shepherds associated them with wet weather. The small scabs in lumpy wool were like wet wax.

In the case of such a disease people were obviously going to speculate on two things: had it always been with them or had it suddenly flared up? The question would have to remain a matter of speculation to a large extent, but perhaps the disease was always potentially present and something had happened in sheep management to allow it to become clinical. The suggestion might be made that the only major change that could have affected the position was a changeover in the type of dip. People should be very careful before assuming that was the answer to the problem. The old type of dip contained arsenic and phenols and a high concentration of arsenic remained in the dip 3 or 4 months later. It was conceivable that the presence of the arsenic could have inhibited the growth of the fungus. Another big difference in the dips was that they now contained vast quantities of detergents. Perhaps that had an effect upon the establishment of fungus in the fleece. Again, that view should be taken very cautiously. A South African worker had ascertained that benzine hexachloride was an effective inhibitor of the growth of the fungus and dip that contained it inhibited the fungus when it was 2 months old.

Now that the disease had been brought into the open—there had been at least two papers on it published in this country during the past 3 or 4 years—surely they should face the fact that something must be done about it quickly. A disease of sheep was important when it caused loss of wool or of mutton. Apparently the wool manufacturers had not yet begun to condemn wool because of a lumpy condition, but the presence of lumpy wool in fleece would put it back a good many grades. If that were so, and the disease were widespread, it was going to be a very important disease, quite apart from it killing sheep or making them extremely ill.

Copper suiphate (0.03 per cent.) in the bath was a good protection against occurrence of the disease, though it was useless for curing it. The question of curing the disease would no doubt cause great difficulty.

Dr. G. J. Kane said they had been aware of mycotic dermatitis in this country over the past 9 years. In 1949 and 1951 clinical outbreaks occurred involving a few Suffolks in Somerset and Rutland. In 1954, an outbreak involving some 40 per cent. of a Somerset flock in the Mendips was studied. On that occasion laboratory investigation confirmed the clinical diagnosis. This flock showed its breed incident to be roughly in the following order :—

Cluns	60 per cent.
Suffolks	40 per cent.
Kerry Hills	40 per cent.
Cheviots	20 per cent.

The manager and his shepherd were both wool conscious and were convinced that prior to 1943 they had had no dermatitis in their flock. In that year, they bought 2 rams from Craven Arms and noticed that they had scruffy skins with some scab formation. The shepherd recognised this condition as being similar to cases observed by him prior to 1910 in his native district of north-west Hereford. If the dermatitis originated from these rams then the different breed incidence could be explained by greater opportunities of contact with the Cluns and by variations in fleece characteristics.

From Table II of the paper one got the impression that Cluns were particularly susceptible. They did not regard this as an indication of breed susceptibility, but rather as a geographical distribution of that breed in particularly wet parts of the country, which made them more vulnerable to the condition. Experimentally, no difference was noticed in the susceptibility of Cluns, Dorset Horns, Suffolk and Scottish Blackface.

The association of that condition with wet weather had been outlined by Mr. Austwick. The type of weather to which the sheep were exposed appeared to influence breed vulnerability. Fine woolled sheep in full fleece required a very heavy rainfall to cause penetration of the fleece and wetting of the skin. Once the skin was wet, it would remain so for a considerable period, depending on the external air humidity. An ideal environment was thus established for the wetting of the skin. Under similar conditions the fleece of open or coarse woolled breeds could dry out before noticeable dermatitis was established. On the other hand, continuous slight rains and even mountain mists might be sufficient to establish and maintain a suitable environment in open woolled sheep, but not in fine woolled breeds.

In the summer of 1955, a very widespread outbreak was rather dramatic in that it was associated with a period occurred on the Welsh-Hereford Border. This outbreak

of persistent rains after shearing, and in all probability was predisposed by the local custom of washing sheep prior to shearing. This outbreak was characterised by the formation of scab on the shorn stubble along the backs and flanks of the sheep. The condition remained active over the course of 2 months and resulted in a very obvious abnormality of the fleece which persisted throughout the early winter months.

They did not agree that pruritus had been an occasional clinical feature. Pruritus was commonly found during the early acute phases of the condition and persisted for a few days after heavy rainfall. The irritation was intense and appeared to be localised in the back. Very many sheep got down on their backs to have a good scratch and were unable to get up again. This irritation had been a direct result of many deaths and was a major economic problem associated with mycotic dermatitis.

To date they knew of no effective treatment for the condition. The difficulty in treatment is associated with the very high resistance of the organism to fungicides and the protected distribution of the causal organism within the skin and in the scab material. A sample of wool with a typical mycotic dermatitis lesion was received from Australia in 1952 and still contained the living organism. The scab material was extremely water-resistant. They had been unable to obtain more than 1 mm. penetration through the scab with dyes dissolved in wetters and other solvents. Histological examination of an infested skin showed localisation of the organism to be far beyond the penetration of fungicidal agents.

Attempts at treatment with arsenic, copper sulphate and phenols had been without success, although some degree of control had been obtained by using quaternary ammonium compounds.

Quaternary ammonium compounds formed a rapid and firm bond on the surfaces of the fleece, skin, and skin exudates which persisted for 62 days when assayed biologically against *Staphylococcus aureus*. While a shorter period of activity might be assumed against Dermatophilus, repeated treatments at 2-monthly intervals appeared to discourage the recurrence of dermatitis from an infested fleece. With such a method of treatment one could normally expect to reduce the incidence of the condition from a normal 80 per cent. to 20 per cent.

He did not regard this method of treatment as a practical solution in that the high rate of exhaustion of quaternary ammonium compounds from the dip wash by adsorption of the active material by the fleeces of sheep made this form of treatment prohibitively expensive. Furthermore, by using a substance which was rather selective in its activity against micro-organisms, one could alter the micro-flora of the fleece and permit the growth of undesirable organisms by the suppression of competitive bacteria. In that respect, the growth of *Pseudomonous pyocyanea* on sheep might cause widespread green staining of their wool.

Dr. Kane concluded by expressing his thanks to Mr. Austwick and Mr. Davies for the excellence of their paper and for the wealth of transparencies with which they illustrated the condition.

The General Discussion

Mr. G. C. Brander (Berkhamsted): "There are two aspects of Mr. Austwick's paper which seem to me to be of particular importance. Firstly, by diagnosing and successfully recovering the mycotic dermatitis organism from so many flocks, he has revealed the existence of a disease condition which appears to have existed for many years. Up to the present much mycotic dermatitis in this country has been referred to as 'rain scald.' The condition as shown in the photographs does not in the milder form resemble the mycotic dermatitis found in Australia and New Zealand. Secondly, it will be important to endeavour to assess the economic importance of the condition in this country. The increased incidence of the disease, if in fact there is an increase, could be related to the many wet summers.

"Mr. Heath has suggested that the disease could have been aggravated by the change in dips and dipping methods. He considers that the increase in wetters in these dips could be a factor of importance. In fact, however, the wetters added to dips to disperse emulsions, or wettable powders throughout the bath, do not increase the wetting effect on the fleece to a noticeable extent. Tests with wettable powders in Australia demonstrated no actual wetting effect on fleeces. In Australia, where over the last 10 years B.H.C., arsenic, and now dieldrin dips have been used, it has not been possible to relate the incidence of mycotic dermatitis to other than changes in climate, *i.e.* very wet conditions.

"I consider therefore that it is important now to continue surveying the incidence of the disease to determine its real economic importance, and at the same time to search for suitable chemicals which may prevent the development of disease symptoms."

Mr. V. S. Cole (Sydney, Australia): "Mycotic dermatitis has been a serious problem in Australia during the wet years following 1950. Two forms occur: an acute form, affecting new-born lambs, and a chronic form affecting older lambs up to 18 months of age. New-born lambs look as though they had been dipped in resin and most of them die. Older lambs develop the typical 'lumpy wool' symptoms. In general the symptoms are not the same as those shown on the slides this afternoon.

"It is a seasonal type of disease in Australia. In one flock in 1956 the whole lamb crop of 12,000 animals was affected. In the following year on the same property there were virtually no lambs affected.

"At present there is no satisfactory method of control."

Mr. N. St. G. Hyslop (University of Bristol): "Although the disease has been described in Great Britain only recently, similar or identical organisms have been recognised for many years as the cause of a severe dermatitis in the tropics. In Africa, the disease (cutaneous streptothricosis) is endemic from the Union of South Africa northwards to the Sudan, and from Kenya in the east, westwards through the Belgian Congo, to the coast.

"Cattle, goats and horses are affected as well as sheep: I have found that some species specificity exists among strains of the organism, but this is not absolute. As with mycotic dermatitis of sheep, the infection commences superficially in these animals, but secondary invaders often cause deep scarring and, in areas where cattle are the mainstay of the local economy, heavy financial losses result from permanent damage to hides.

"Like mycotic dermatitis, cutaneous streptothricosis is particularly prevalent during and after wet weather, and, in those areas where monsoonal rains occur, severe outbreaks are seen which tend to regress during the intervening dry periods—only to flare up again with the succeeding rainy period.

"Thus, the tropical disease is virtually indistinguishable from the mycotic dermatitis seen here, and I understand that, in addition to the isolation of the organism by Dr. Stableforth some 20 years ago, the condition has been seen fairly recently in cattle and horses in the United Kingdom. I feel that the Congress would be interested to hear whether any of the speakers have personal experience of this, and whether they believe that in the future the condition is likely to become a serious menace in Europe to animals other than sheep."

Mr. D. W. Kerruish (Isle of Man): "This condition has been known here for some considerable time, and severely affected animals have often been described as having been 'burnt with the dip.'

"There is no doubt that the condition can cause economic loss. At the Isle of Man Board of Agriculture's Wool Control centre fleeces were examined and found to have been down-graded as a result of this disease. Fleeces which would otherwise have been graded as 'Fine (1)' were reduced to 'Fine (Heavy)' because of the minute scabs scattered throughout the fleece. There also seems to be some possibility that the staple is damaged.

"Two rams were recently imported here from Ireland, and one of them had typical lesions of mycotic dermatitis on arrival.

"I cannot agree that pruritus can be temporary: cases have been noted in which the pruritus has been persistent.

A number of these cases have included rams which, in addition to the usual lesions on the back, have had lesions also on the scrotum."

Mr. J. C. Wood (Berkhamsted): "I would like to mention an aspect of this condition which at the present time is of only potential importance. In the acute stage the moist lesion of mycotic dermatitis is extremely attractive to blowflies, and as the condition is affected by climate a considerable proportion of a flock may become susceptible to blowfly attack at one time. Fortunately, dieldrin appears to be able to control these infestations, and so far they have not proved to be of any economic importance. Resistance of blowfly larvae to dieldrin has already been confirmed in Australia and although it may never occur in Britain, we must at least consider the possibility that we may not always be able to rely on the protection afforded by this insecticide. We have been rather disturbed to find during tests with other larvicides which have proved satisfactory overseas, that in British conditions they appear to fail when an outbreak of mycotic dermatitis appears in a flock. This loss of biological control happens quite suddenly, and a high incidence of body strikes may occur in a flock in which the insecticide is still able to prevent infestation in other predilection sites, such as the soiled crutch of sheep which are scouring. Out of 5 flocks dipped in one of these insecticides at the beginning of this summer, protection has failed in 4, when lesions of mycotic dermatitis became active."

The Reply

Mr. Austwick, in reply, said that it would unfortunately not be possible to reply to all the questions individually but many could be answered in general terms. The discussion had brought out two fundamental points which had already been discussed at Mr. Dall's paper on the previous day. One was that we do not all use the same terminology for describing skin conditions and it was to be hoped that more detailed descriptions would lead to a better understanding of these diseases. The other point was that the treatment of skin diseases as a whole needed to be approached with a knowledge of the natural cycle of development of each disease. The tendency for spontaneous recovery to occur meant that clinical trials of therapeutic agents were of little use in assessing their value and the only certain method was to use experimentally induced lesions the development of which could be accurately predicted. For mycotic dermatitis there was really no satisfactory treatment at present and a great deal of experimental work was required.

The differential diagnosis of mycotic dermatitis particularly from "orf" (contagious pustular dermatitis) was one of the major problems but in all the outbreaks described filaments of Dermatophilus had been detected in the scabs. On a number of orf-immune animals, typical lesions of mycotic dermatitis had been obtained using both field material and pure cultures.

Some attempt had been made to obtain information on the economic aspects of the disease from farmers with affected flocks and these had been described in the paper. One owner who had been visited by Mr. Davies and himself on several occasions had lost heavily on his recent wool clips but it was impossible to say how many other owners were in a similar difficulty. The position on the Isle of Man was probably a useful pointer to what must be a similar state of affairs on the mainland, although at present no comparable survey had been undertaken there. The disease was detected in all 33 flocks examined and had an incidence of 20 to 100 per cent. but only 3 owners had considered it to be sufficiently important for them to draw the attention of their veterinary surgeon to the state of their sheep. A further survey carried out by Mr. E. T. Davies, Mr. H. E. Roberts and himself at a recent mainland sheep sales produced surprising results in that it was estimated that some 98 per cent. of the flocks represented showed some signs of the disease and that many animals were so severely infected that they had lost wool.

The development of the disease seemed to be associated with a change in sheep husbandry in recent years and one of the major changes that had occurred was the introduction of new dipping compounds. There was some evidence for incriminating these as a factor favouring the disease but it was by no means conclusive.

It was fairly clear from what had been said by the contributors from Australia and New Zealand that we were all dealing with the same organism and disease but the clinical condition was very different. It would be necessary to study the environment and the disease itself in Australasia and this country comparatively before the same principles of control could be applied in both areas.

Following what appeared to be the first record of the disease in cattle in this country by Mr. H. E. Roberts it seemed likely that there would be increasing numbers of reports from bovine animals. At present the lesions seen were mild but the position could be serious if they became as bad as those encountered in Africa. In horses the disease had been found occasionally by Dr. G. J. Kane and, in fact, had first been described in this country from a horse by Dr. A. W. Stableforth long before the condition had been discovered here in sheep.

The Extent and Scope of an Artificial Breeding Programme for Cattle

BY

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SUMMARY.—1. A development of artificial insemination in cattle is reviewed and figures for its progress are given, both at home and abroad.

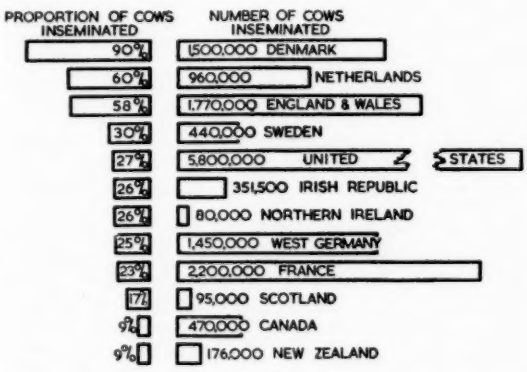
2. Various aspects of the record system are examined and practical comments are made on factors likely to assist the veterinary surgeon in evaluating field problems and gaining experience of the A.I. centre's functions.

3. Livestock improvement through A.I. is discussed and ways of achieving its objective are mentioned.

4. Future development of the A.I. industry gives cause for healthy optimism and assumes a valuable link with the veterinary profession for those with adequate technical and husbandry interest.

FEW new techniques can have made such an international impact on our livestock industry as that of indirect mating by the use of artificial insemination (Hammond, 1955). In a space of less than 25 years the process has passed from the obscurity of the laboratory to become a well established and accepted part of the dairy industry in so many countries where geographical and climatic conditions do not limit its progress.

TABLE I



It will be seen from Table I that at the present time, apart from Denmark, there can still be a very considerable expansion of the industry almost all over the world.

The primary object of any A.I. programme is one of livestock improvement and any additional advantages must be taken as of secondary importance. In some cases countries have made a more conscientious approach to this aspect of the work than others, with the result that expansion has been delayed until the bulls with good proofs are available. New Zealand falls into this category (New Zealand Dairy Board Report 1957).

Although one is able only to quote the extent of the A.I. programme in the more actively engaged countries, there are few areas of the world's surface now that remain outside its range and, as the trends of world economy demand higher standards of living, so we can look forward to an ever-increasing utilisation of both dairy and beef sires by the A.I. technique.

Much is owed to those early pioneers who had the foresight to recommend the development and expansion of the technique (Edwards & Ritchie, 1944).

Attention has already been drawn to the international involvement of the A.I. technique. Let us now look at our own country, take stock of the A.I. programme's extent, and the possible contribution it has made to the knowledge of the practising veterinary surgeon.

To look upon the A.I. service as something available to produce semen for the purpose of getting cows in calf and nothing more is obviously quite wrong. Never before have so many fields of new endeavour been opened and the not inconsiderable annual list of publications in all aspects of the A.I. field shows the extent to which both veterinary and non-veterinary research workers have taken advantage of the new technique. These less obvious fields of endeavour may go unnoticed by the practising veterinary surgeon and to make mention of them may be of some value.

Practical Utilisation of A.I. Centre Data

Fertility Data

All well-run A.I. organisations have for many years been in general agreement that no efficient service can be given without adequate records. At the present stage it is unlikely that even the larger operators of the service in this country will depart from this view. Bartlett (1957) has suggested that a record sampling technique can be effectively used when large numbers of inseminations are being carried out with each semen sample.

As the question of breeding efficiency levels is so closely associated with the A.I. industry, it is essential to refer to this field in general terms before dealing in more detail with but a few of the fertility factors affecting the artificial breeding movement.

Over the years adequate reference has been made to the general field of infertility in both the female

and male bovine animal, but, with the not inconsiderable impact which the A.I. movement has now made on the dairy herds of this country, a rather particular and perhaps too little recognised field of infertility has arisen. More than passing reference should, therefore, be made to "management" infertility in A.I. herds.

All those closely associated with the A.I. movement only too readily appreciate how a breeding problem can so easily be created by the owner or attendant's inability to carry out the basic requirements of good stock husbandry. At field level so many times, A.I. is said to have failed while the bull has succeeded, not only for the individual animal but for a number of cattle in the one herd ownership. It can never be too strongly stressed that all veterinary surgeons called upon to investigate an A.I. breeding problem should dwell at some length on breeding management as it affects the A.I. centre before attention is turned to the infectious and other fields.

To concentrate too much upon the pathological approach to the infertility problem is often dangerous and the outcome not as satisfying as adjustments of service management which can so often resolve a position of sub-fertility.

Reference has already been made to the impossible task in a paper of this description of dealing with the field infertility problem but data can be given on some aspects of the condition as seen from the A.I. centre.

Male Fertility Data

Numerous aspects of fertility data on bulls have been examined over the years (Blom, 1950; Hancock, 1953) but, apart from the extreme cases of sub-fertility or sterility, we are still unable to predict with any real certainty the fertility of an A.I. sire until used under field conditions.

Intake of sires to the A.I. movement must provide information on the general fertility level of a given male population and, although to some extent the sample is biased in favour of the well-reared bull, experiences have been most satisfactory. Of 205 young dairy bulls coming into the organisation since mid-1955, only 5 have been disposed of within the first year for reasons of poor fertility which shows at least that present testing procedures must be very adequate. The wisdom of making too hasty a decision on the young bull's service potential and semen production has been well emphasised in the past, and the B.V.A. (1957) has made some contribution in this field by trying to standardise approval requirements.

Conception Rates by Breed

While there are known disadvantages to this method of interpreting breeding efficiency figures, as long as all organisations use the same 90 to 120 day conception rate index a similar standard is at least being adopted.

In general terms it would appear that the Welsh Black breed has a very high fertility index, while the Channel Islands cattle are less efficient breeders when used under our conditions of commercial A.I. Broadly speaking the remainder of the breeds fall into a very solid fertility level.

In dealing with fertility data under A.I. conditions, in fairness to breeds various factors have to be considered which can very easily affect the overall C.R. and, therefore, allow inaccurate conclusions to be drawn from such calculations. However, at least in the case of the Channel Islands cattle their lower non-return rate in the male does seem to bear some relationship to the calving interval in the female when data from National Milk Records is examined (see Table III).

The age of a bull and its effect on conception rate

While it is known that the population of senior bulls within the A.I. movement is likely to increase constantly, there is ample evidence to show that lowered fertility need not accompany increase in age, at least under A.I. conditions. This is of some importance when we realise how essential it is to utilise older sires to their maximum.

TABLE II

SUMMARY SHOWING USE AND PERFORMANCE BY AGE GROUP OF A.I. SIRES—JANUARY TO DECEMBER 1953

Year of birth	Paid inseminations	C.R.	Year of birth	Paid inseminations	C.R.
1940	1 (2,100)	66·2	1946	67 (121,211)	65·1
1941	2 (1,372)	66·8	1947	86 (134,579)	68·7
1942	8 (11,687)	64·7	1948	92 (177,386)	68·8
1943	19 (37,907)	64·1	1949	82 (127,979)	65·7
1944	28 (49,284)	66·2	1950	75 (97,690)	67·5
1945	44 (77,345)	66·5	1951	29 (36,053)	68·5

533 bulls carried out 874,593 final service C.R. 66·9 per cent.

Variation of conception rate within bulls has been recognised through the use of A.I. service. When bulls are responsible for large numbers of services, provided the number of services per ejaculate are numerous, the possibility of technical deficiency cannot be entirely overlooked, although probably the deficiency is more likely to be on the part of the laboratory worker in not recognising a variation in semen quality than in the use of the semen or the female population receiving it. To associate this C.R. phenomenon with an infective infertility syndrome may be misleading and is in need of more careful study.

Female Fertility Data

Comment has already been made on the question of infertility in respect of the A.I. movement, but very often too few appreciate normality.

The whole field of infertility in dairy cattle has become somewhat obscured by the lack of knowledge of the normal breeding pattern of our dairy

population and, while one would not wish to minimise the importance of a reduced breeding efficiency, the full extent of the problem should always be carefully examined.

We are familiar with numerous wastage survey figures (Withers, 1955, & Milk Marketing Board, 1957) in dairy cattle under the broad heading of loss due to infertility, but on many occasions these losses are not as real as they appear at first sight in that the number of services per cow before disposal may be small, and lowered yield plus the enticement of a lucrative commercial beef market may be an encouragement to the owner to dispose of returning females. One can hardly refrain from assuming the greater the value of the breed on the beef market, the less desirous is the owner of facing a breeding problem in an individual cow.

Under A.I. conditions herd record cards tend to show that a comparatively small number of herds experience a total drop in fertility throughout a whole female population. In order to have some indication of normality in a population of both A.I. and natural service herds the average calving interval has been examined and, in dealing with any infertility problem, be it the individual animal or the herd, one must always bear "normality" in mind.

The present method of conception rate calculation does, on occasion, appear to conceal the full extent of the temporary infertility syndrome, for, on the examination of herd records for the first 100 herds with 5, or more, services in 1957 during May, 1958, 3 regions covering 1,400 herds (14 A.I. centres) showed that 14 per cent. of the herds had less than a 50 per cent. conception rate to first service. This does not, of course, mean that the herds were in a stage of long term infertility, rather was the fertility level temporarily less successful when compared with other herds using the same bulls and operators. It should be said that all the A.I. centres studied had a 66 to 72 per cent. C.R. to first service during the period of this study.

The national pattern of some 392 days between calvings in all milk recorded herds shows that a calf every 13 months is the average in a partly selected population of dairy cattle.

TABLE III
AVERAGE CALVING INTERVAL (CHANNEL ISLAND)

Region	Guernsey	Jersey	All breeds
Northern	415·6	397·3	398
North Western ...	402·8	391·5	392
Eastern	402·2	383·5	383
East Midland ...	408·0	394·5	395
West Midland ...	402·3	393·3	391
North Wales ...	400·7	403·0	395
South Wales ...	358·3	397·7	394
Southern	399·4	388·5	391
Mid Western ...	396·6	388·6	387
Far Western ...	401·6	384·2	391
South Eastern ...	404·2	388·8	394
England and Wales	401·5	390·1	392

Source : Tabulation of 88,957 lactation cards Pedigree and Grading-up 1955–6.

It is realised that milk recorded herds may, in part, enforce a long calving interval to encourage a higher lactation, but with the competitive nature of milk production at the present time, any owner is unlikely to extend the length of a lactation beyond what may be considered economical.

Management Infertility has already been referred to, but under A.I. conditions, when a very big population of the membership is taking advantage of commercial milk production, it would be unwise to minimise the importance of the short *post-partum* intervals and the part they play on reduced breeding efficiency as calculated on a 90 to 120 day non-return figure.

TABLE IV

Days interval between parturition and first insemination	Number of cows	C.R. to first insemina-tions	C.R. to first repeats*
		Per cent.	Per cent.
0– 30	139	48·9	60·6
– 60	772	52·7	62·0
– 90	1,037	62·5	67·6
–120	501	66·0	74·7
–150	198	72·2	80·0

* Conception rate calculated on first repeat inseminations of cows in group not in-calf to initial insemination.
Numbers are very small in first and fifth groups.

Seasonal milk production and previous poor breeding performance does tend to encourage the average herd owner to present cows for service too soon after calving.

The effect of season on female fertility has always called for comment in lay circles. So many believe that spring and early summer fertility levels are higher than at other times of the year, but, based on first services at least, there appears to be little seasonal variation.

TABLE V
SEASONAL EFFECT ON FERTILITY*

	Jan./ Mar.	Apl./ June	July/ Sept.	Oct./ Dec.	Total
1955	320,444	326,210	237,080	346,676	1,230,410
	64·7	66·1	67·6	67·8	66·5
1956	369,219	359,669	245,735	376,658	1,351,281
	65·3	67·4	69·6	68·7	67·6
1957	369,702	375,174	260,642	379,902	1,385,420
	66·9	67·8	69·6	69·4	68·4

* C.R. table with three-year split by quarter : all board A.I. centres.

Herd size and fertility levels have been commented upon and it would seem that the larger the herd, the lower the conception rate as based on successful first services. Under A.I. conditions this might be expected when we appreciate the importance of observing signs of heat in detail.

The time up to which telephone calls are taken in the A.I. organisation has varied over the development of the commercial A.I. technique. A reduction in telephone times invariably brings some criticism from the users of the service. However, apart from

certain extreme geographical limitations, it appears that after a period of readjustment the membership can achieve most satisfactory results. In 1957 the Board reduced times for taking telephone calls to 10 a.m. and it will be seen that there was no decrease in breeding efficiency as a result of this change.

TABLE VI

Region	12 months prior to change		12 months after change	
	Number of paid inseminations	Conception rate	Number of paid inseminations	Conception rate
		Per cent.		Per cent.
East ...	198,980	63·0	203,910	64·5
North ...	234,994	68·1	238,037	69·7
Midland ...	309,744	66·7	305,358	68·0
Wales ...	273,931	71·0	291,442	71·2
South West	333,631	68·1	346,677	67·6

Fertility data in respect of both the male and female bovine animal has been considered, but the utilisation of the A.I. technique brings in further fertility variations. These included quality of the semen and the efficiency of the inseminator involved in the actual field service.

It must always be remembered that the A.I. service is given with a commercial basis and, therefore, those operating such a service are unlikely to be satisfied with poor fertility levels of either bulls or personnel. However, passing reference can be made to certain factors in this field.

In respect of the Milk Marketing Board at least, monthly reviews of both bulls' conception rates and of each individual worker's results take place, technical staff act at once, should it be necessary, in the hope that any reductions in breeding efficiency may be restored. There is little evidence to support the belief that high daily output (20 inseminations, or more) reduces conception rates achieved by the individual operators.

Age at which semen is used in the field is well-known to affect conception rate, but in respect of the fresh semen market some 70 per cent. of inseminations are carried out with liquid semen of up to 48 hours in age. However, research continues in an effort to extend the fertility of liquid semen, for it is realised that if this can be done for up to 96 hours (Almquist, 1957) considerable advantages could accrue—wastage of semen would be less, centres would be less bound to a daily collecting routine and the expense of providing frozen semen storage would be avoided. Research in this field is encouraging.

The new field of frozen semen must not go without comment, especially as the change to such a technique takes time and much readjustment. Progress on a national scale is being made, but to encourage this technique at the expense of bull numbers is not, at the present time, envisaged as sound practice.

Sire Wastage through A.I.

An extremely satisfactory pre-entry testing procedure has always been in force for sires entering A.I. It has, without doubt, stood the industry in good stead during its entire period of operation.

Even when pre-entry health and livestock checks are so efficient, a certain number of bulls must be eliminated and the figures given below indicate the proportion which appear not to meet the approval of the licensing authority.

TABLE VII

BULLS EXAMINED FOR A.I. IN ENGLAND AND WALES

	Year ended	Examined	Reason for rejection	
			Live-stock	Animal health
1st examinations ...	31.3.56	344	83	87
	31.3.57	464	97	108
	31.3.58	536	96	108
Total 1st examinations		1,344	276	303
Re-examinations ...	31.3.56	48	2	12
	31.3.57	54	5	16
	31.3.58	61	3	20
Total re-examinations		163	10	48
Total all examinations		1,507	286	351

The majority of A.I. operators will, of course, have done some considerable culling on both livestock and health grounds before bulls are placed before the Ministry for consideration, and this must be borne in mind when assessing the figures.

The wastage once within the A.I. centre is of interest. With a large bull stud there is a constantly changing population, but the overall age of sires within the A.I. movement continues to increase which in itself must speak well for stud management methods.

While it is impossible to obtain *post-mortem* reports on all disposals, some useful data is being accumulated. It should be realised that many normal healthy bulls are included in this sample, only being disposed of because their progeny do not conform to breed standards.

Hazards of the A.I. Technique

The bull once in the A.I. centre is capable of a long and fertile life, but the very nature of his constant work must subject him to at least a few "occupational" hazards, among the most common being lameness and minor injury to the penis. Generally, it can be said that the male bovine animal is very resistant to temporary sickness, but this can occur and is always noted in case it may have a side effect on fertility at a later date.

In respect of the female, the actual insemination technique remains free from criticism. When it is realised in the Milk Marketing Board A.I. organisation alone close on 2 million actual inseminations

TABLE VIII
REASONS FOR DISPOSAL

	A.A.	A.	D.S.	F.	G.	H.	J.	L.R.S.	R.P.	S.D.	W.B.	Total
Total number of bulls disposed ...	1	14	20	38	6	16	2	1	2	0	2	102
Progeny below standard	0	5	12	22	1	0	0	0	1	0	2	43
Poor semen only	0	2	2	3	4	5	0	0	0	0	0	16
Poor service behaviour	1	2	1	0	0	4	0	0	0	0	0	8
Low conception rate	0	0	1	2	0	2	0	0	1	0	0	6
Inco-ordination of hindquarters ...	0	2	0	1	1	2	0	0	0	0	0	6
Accidents	0	1	1	2	0	0	0	0	0	0	0	4
Johne's disease	0	0	2	1	0	0	0	0	0	0	0	3
Poor type	0	0	0	2	0	0	0	0	0	0	0	2
Lame	0	1	0	0	0	3	2	0	0	0	0	6
Miscellaneous	0	1	1	5	0	0	0	1	0	0	0	8
Reproductive failure	1	4	4	5	4	11	0	0	1	0	0	30

Under the heading of " Reproductive failure " are grouped bulls disposed of due to poor semen production, poor service behaviour and low conception rate.

A.A. = Aberdeen Angus. F. = Friesian. J. = Jersey. S.D. = South Devon.
A. = Ayrshire. G. = Guernsey. L.R.S. = Lincoln Red Shorthorn. W.B. = Welsh Black.
D.S. = Dairy Shorthorn. H. = Hereford. R.P. = Red Poll.

are being carried out each year, it can be seen that the technical risk of inseminating a cow is small and can hardly warrant any change at this stage in apparatus or departure from existing training procedures. ?

TABLE IX
A.I. INSURANCE SCHEME

Period	Mismarked calves	Mechanical abortions	Injury to cow	Totals
July to December, 1955	51	7	9	67
January to December, 1956 ...	123	14	16	153
January to December, 1957 ...	120	15	25	160
January to May, 1958	58	5	7	70
Totals ...	352	41	57	450

Claims in some cases must be examined in the greatest detail, and the co-incidental nature of deaths within a very large inseminated population can never be overlooked where evidence is not adequately presented.

Collection of General Field Data

There has always been a deficiency of information in respect of the relative importance of various losses due to disease in our livestock. Various workers have surveyed special sections of the dairy industry but up to now there has been no machinery to provide quickly any interested body with facts which can be of value to the veterinary research worker.

Work on disease survey has always been efficiently carried out in New Zealand through the employees of the Dairy Board, and in this country already material has been published after collection from a special section of dairy farms.

Answers to concisely worded questions can be very effectively obtained through the use of lay personnel and already the technique has been used to carry out incidence surveys on Johne's disease and also to see how farmers are using the S.19 vaccine programme (Milk Marketing Board, 1958).

The utilisation of 2 million farms visits a year for other valuable work cannot be ignored. In addition to the work already mentioned, collection of data for future assessment of inherited and developmental abnormalities in our cattle population is in hand, for the exact extent of the problem has not been so far fully assessed (Gotink, 1955, & Morley, 1954). The desirability of concise and informative descriptions of such abnormalities is, over a total cattle population, lacking and the collection of extra data is already proving of some value. Up to the present time 550 reports have been received and range over a very wide field. The entire A.I. industry must look to the practising veterinary surgeon for assistance in this field, for without his interest many defects will go unrecorded.

Livestock Improvement Through A.I.

The primary object of a commercial A.I. service has always been to provide what the operators believe to be sires capable of transmitting above average progeny.

Robertson (1954) in examining early A.I. results in speeding livestock improvement found yield improvement to some extent disappointing. The

TABLE X

Year ...	Ayrshire	Friesian	Jersey	Guernsey	Shorthorn	Red Poll	Total
1955 ...	6	29	5	4	9	–	53
1956 ...	19	34	4	8	21	2	88
1957 ...	13	56	7	11	13	1	101
	38	119	16	23	43	3	242

continued interest in the field of sire selection with added strength from the official National Milk Recording movement must, however, continuously improve the situation as selection standards are elevated.

Despite early disappointments, there continues to be a steady increase in the estimate of yield per cow. In 1956-7 the average was 720 gallons, while in 1957-8 it was 745 gallons which is well above the annual increase of 15 gallons per cow for the past 10 years.

The operators of A.I. would not wish to take the entire credit for the general improvement in the yielding ability of our dairy herds, for without better herd management few can hope to succeed. Indirectly they can take credit for assisting in education programmes and also for having made available to the dairy industry a selection of breeds which has allowed the herd owner to select a cow of a breed capable of producing milk most cheaply under his particular conditions.

The danger of selection on small numbers of records from a well managed herd has been recognised for several years, and new methods of selection, especially for the A.I. sire, have been considered of absolute necessity.

The contemporary comparison, *i.e.* a method of comparing heifers by different sires on a within herd basis has now become a valuable improved method of sire selection (Milk Marketing Board, 1954), and this, coupled with active panel inspection, is constantly showing general sire improvement. Alongside these improved selection standards there is now an increased desire to slaughter bulls whose daughters fall below breed standards as soon as averages are available in sufficient quantities to be satisfied of the bull's transmitting ability.

Besides a Milk Recording movement there must be a progeny testing programme for young sires coming into the industry and any well managed A.I. service will always regulate its young sire intake to conform to the population of milk recorded cows available for a testing programme.

A variety of methods have been evolved to progeny test dairy bulls and each one has its merits. In the case of the A.I. movement, however, it would seem that the users of the service may well benefit most from a testing programme based on the potential of cattle under conditions of commercial milk production. Therefore, at the present time young sires are being evaluated in the majority of cases on a "First 500" scheme. Adequate daughters ultimately come into the milking herd throughout the country to provide an unselected test on the dairy bulls under observation. Since the inception of this scheme in 1955 over 200 young sires have been put on test and 140 have completed their test period.

New fields of endeavour are developing in the beef cattle industry now that the dairy industry is making such a marked contribution to beef production, 35 per cent. of all inseminations being to beef bulls. Performance testing of beef bulls is obviously necessary under such conditions.

A close correlation between weight gains of the bull calf during his rearing and that of his resulting progeny has shown the advantage of performance testing future beef sires and a technique is now being developed in this country to cater for the need which has already been recognised both in Canada and America (Raithby, 1957; Woodward, 1954).

As present trends appear to show that much of our beef is likely to come from the dairy herds of this country, the field must obviously be explored to the full.

The Future of the A.I. Movement

The technique of artificial insemination has now become firmly established in this country and as the years progress goodwill between operators and users of the service increases. It can, therefore, be predicted that there will continue to be an increased demand for the service providing the dairy industry remains in a vigorous and healthy financial condition.

To hope for expansion at a rate comparable with past years would, however, be unreasonable. There is, however, every likelihood, as the pedigree breeders become more conscious of sire selection methods, that an ever increasing demand will come from that side of the industry.

Technical advances are likely to be made within the industry but the fertility barrier of the female bovine animal may well prevent any marked improvement on conception rates above those already being achieved. However, if these can be maintained, and there is every confidence that they will as the cattle owner becomes even more accustomed to the service, there can be no real disadvantage to the service in its present form.

The whole infertility field remains confused and so far little real progress has been made in diagnosing the causes of interrupted breeding, or, for that matter, to provide well tried treatments which may be of value. Numerous opportunities have been taken abroad by the A.I. movement to enter the field of treatment studies, but so far very little of value would appear to have resulted from these, and one has to be almost forced to conclude that the veterinary surgeon's place in the infertility field is, with few exceptions, at the present time disappointing, not because his endeavours in the field are lacking, but because there has been too little valuable controlled work carried out over the whole infertility field, whether it be in the sphere of cause, general diagnosis, or treatment.

The research value of the A.I. movement is immense. It has many opportunities still unexplored and as time passes new achievements must come from within the industry in all fields, either through the bull studs themselves or through the equally profitable field of membership contact.

Frozen semen has its part to play in the widespread use of top sires. Furthermore, the technique must have some contribution to make to the long term planning of breeding programmes which had up to now been undreamed of.

The extent to which top sires are used in the A.I. industry will depend on the continued advances in the research field. Even now, much can be done to improve the existing position if, and when, long

term storage of fresh semen is made available. The very fact that the areas covered by our studs are comparatively small means less satisfactory use of senior sires and it may, therefore, be desirable in the future to increase cows per bull by even better fresh semen utilisation methods.

Present trends in improved methods of sire selection must continue and, as a result, it is reasonable to assume that the prediction of genetic worth in young sires will become more accurate and give an ever-improving plane for selection. The place of the pedigree breeder will remain firmly established, and the position of the breed society likewise, and one would predict a closer liaison between them and the A.I. movement. Up to the present, however, there has been an increase in registrations in pedigree herds by A.I. sires; in one of the largest breed societies last year 25 per cent. of male and 20 per cent. of female registrations were by A.I. sires.

The A.I. technique seems up to the present to have been exploited but little by the private breeder for, despite the new advantages of frozen semen and a more liberal licensing procedure, comparatively little use is being made of the interchange of semen between our pedigree breeding herds, a procedure which must be infinitely more safe than the exchange of sires.

As an aid to more accurate genetic improvement, the greater use of blood grouping services and blood research may well be expected, not only as a device for checking parentage but also for deeper studies of genetic relationship through the chemical composition of bloods (Ashton, 1957).

The advances in technique and the value of the A.I. industry to the dairy farmer of this country have been well emphasised, but the practising veterinary surgeon may on many occasions not appreciate how much the establishment of this service has meant to his daily prosperity, especially in the country where a very high percentage of cows are being inseminated. Milk yields have increased and, although overall milk prices have dropped, the industry as a whole has annually been paid more for its production.

The veterinary surgeon in practice has become increasingly accustomed to working with the A.I. service and the personnel; he has become aware of the part all have to play in this comparatively new benefit and is quick to realise the mutual advantage of its success.

Those operating the service value the mutual exchange of interest and know that the future will hold much of value for all those so closely associated with the dairy cattle industry.

Acknowledgments.—The writer wishes to thank the Head of the Production Division of the Milk Marketing Board for permission to publish material from its records, to all colleagues who so freely gave access to such information, and to the Ministry of Agriculture, Fisheries and Food for material in Table XIII.

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THE SPEAKER'S INTRODUCTION

Mr. G. F. Smith said that it had been shown, on the occasion of the 76th British Veterinary Association Conference, how closely the profession was interesting itself in the affairs of the livestock industry. Not only had a plenary session been allocated to that field, but an opportunity had also been given for the A.I. movement—probably one of the most potent instruments in attaining that improvement—to move closely to the practising veterinary surgeons of the country.

The apparent genuine interest of the profession in animal breeding forced him to mention the title of the single paper presented at the 15th National Veterinary Association Meeting held at Reading in 1897, "Heredity in its Relations to the Diseases of Animals." Although it must be presumed that there had been a change of interest in the animal, it was obvious from the programme of proceedings that interest in that wide field remained.

In his paper the author had tried to range over the field of A.I. records and had mentioned other factors which might be of some interest to the practising veterinary surgeon, who at this stage in the development of A.I., must be coming in daily contact with the operation of the commercial cattle breeding programme throughout the British Isles.

In introducing a paper of that description one could hardly avoid giving priority to the problem of reduced fertility in dairy cattle, and also those factors which had previously been little mentioned as attributing to that state in an age of artificial insemination. The whole future of infertility research into the causes and treatments of impaired breeding efficiency was, in his view, in need of a careful review, for although there might have been some reduction in the size of the problem with the coming of A.I. and improved knowledge, there still remained much work to be done in that field.

It was Asdell who, after reviewing the whole field of infertility, recently wrote, "In general it is believed that the present knowledge of reproduction and the possibility of its control in the bovine lags because many of the basic problems are still unsolved." That must be an accepted statement of fact by all those fair minded people associated with the field. There remained the problem of sorting out the pathological from the normal, the assessment of dependable treatment and the placing of causes in their proper order of priority.

Much useful information on the appraisal of normality had come from A.I. records, and contributions on infertility in survey form by Boyde and Ogden in this country and Maclure in New Zealand still showed the need for careful thought in planning future research projects. Once having established normality, all workers must start to look for a new field of approach if a solution was to be found for

the hard core of problem herds. The importance of the veterinary surgeon's rôle within the infertility field must not be overlooked, for as the dairy and beef industries became increasingly competitive, both economically and genetically, it would be even more important at least to try to prolong the life of breeding stock beyond present limits.

Various experiences in aspects of male fertility and wastage had been mentioned in the paper under discussion. Here again it was necessary to look upon the task of preserving the male as an important one for, as the number of bulls licensed became less (1945—33,189: 1956-7—19,202) so the value of those in use became greater, not only within the A.I. movement, but also at herd level, for ultimately with the improved methods of selection and breeding one could look forward to an ever increasing number of superior sires in circulation.

With the extension of the A.I. service over such a wide field, those responsible for that service believed there was little to fear from the introduction of undesirable recessives. However, the reporting of such abnormal occurrences through the cattle population was of some importance. Factors developmental and inherited in origin needed proper classification and only by co-operation on all sides could a balanced picture be given.

Having seen the organisation of A.I. in various overseas countries one must be justly pleased with its development in the British Isles. The 33 bull studs giving the service had done so with efficiency and continued to provide a service which was dependable and ultimately must be destined to raise the general standard of dairy herds.

In the new and fast moving field of cattle breeding one would be cautious in speculating where next developments might come, but from investigations in hand one must expect continued hope of improving the satisfactory fertility levels of the present time by finding an acceptable solution to the problem of early embryonic death, and other more obscure factors which must be playing some part in early foetal mortality.

The major interest must be one of livestock improvement. Therefore, steps must be taken to see that all technical advances were made use of to ensure full utilisation of semen from outstanding sires. That must, in turn, increase the interest which the pedigree breeder would have in the movement, so that in the long run the whole livestock industry would benefit. Who knows, sex selection might not be far off, and that might not seem so revolutionary when it was realised what steps had been taken to preserve to posterity germ cells during the past few years. The use of improved methods of sire selection and management methods must in the future bring closer a more economic unit for the production of both milk and meat. If in fact the present traditional breeds did not compare favourably with those from overseas, perhaps there should be no hesitation in creating new breeds to fit requirements. The veterinary surgeon must remain closely in touch with developments in the field of A.I. for his prosperity was in no small measure associated with its progress and continual development.

For its part, the A.I. movement had much to gain from constructive co-operation and it was hoped that in the future the profession would show as much well-thought-out interest as in the past when deliberating on matters of mutual interest.

The Openers

Mr. D. H. L. Madden, in opening the discussion, said that seldom had the profession been presented with a more monumental piece of work than that described by the paper. Seldom had a field project of such magnitude with such profound potentialities and public implications been within the technical guidance of one man. When it was realised that he had been responsible for the technical organisation resulting in more than 10 million artificial matings in cattle, it would be appreciated that no man was more qualified to produce the review of the development of A.I. than Geoffrey Smith.

As a comparative newcomer to the field, Mr. Madden said he desired to record his gratitude and appreciation to the organisers for the honour in asking him to open the discussion. The problems which confronted the Hampshire Cattle Breeders were frequently similar to those affecting the Milk Marketing Board. A great deal of liaison had transpired in the past between them, and he desired to thank the Board for their unstinted co-operation which his Society had found extremely valuable.

Those present had been reminded of the basic aims of the pioneers of A.I. in this country. One was conscious that, whereas conformation and type had been standardised, there was little doubt that the foremost practical gain that the pioneers hoped A.I. services would produce—yield improvement—had not been realised to the degree expected. There had been 4 main contributory causes to that disappointment. First, lack of interest by the farming community, leading to great losses of data concerning the offspring bred. Secondly, lack of perseverance by A.I. authorities in collecting those data to combat that lethargy. Thirdly, misguided worship of phenotype irrelevancies in show standards for the dairy animal rather than paying due regard to measurable factual evidence concerning performance. Fourth, hypocritical and irresponsible political censorship of hereditable defects that came to light; a policy pandered to by A.I. authorities and breeders alike. The time had come when progress beyond a certain point would be slow and only made by critical scientific methods. If obeisance were made to personal whims and fancies, a lull in improvement would be the inevitable frustrated outcome. Close and honest collaboration was required between breeders, geneticists and veterinarians, unimpaired by personal bias, so that clear concepts of purpose might be agreed and a united impartial effort made.

The general practitioner, in his everyday contact with farmers, had an important part to play. If he was familiar with the breeding potentials of the sires available, he was able to advise the best methods of exploiting the potentials hoped to be transmitted by management of the environment. He could also help in accumulating and classifying reliably the hereditably undesirable characters in the calves born. Ruthless culling of those was necessary and he must beware of aiding them to be masked by corrective operation.

Side by side with the stasis and disappointments experienced from the genetic viewpoint, it was also quite clear, however, that the secondary aim of the pioneers, that of enhanced fertility, had transcended all expectations. Venereal diseases had been largely eliminated. It had been learnt that from the male viewpoint there was a fertility barrier beyond which it was difficult to advance. It was known that the female population must be attacked if fertility were to be improved much in excess of the normal *circa* 70 per cent. 90- to 120-day conception rate. The mortality of embryos must be eliminated by enhancing their prosperity through improving the uterine environment.

A.I. had nevertheless brought with it fertility problems which might not have prevailed before. He heartily endorsed the author's views concerning the management of the oestral animal. The management factor certainly seemed to increase with the size of the herd. In a recent survey over 15 per cent. of herds consisting of 20 animals or more had conception rates of 20 per cent. less than the average. With herds of less than 20 animals only 4 per cent. had such conception rates. Although the herdsmen's ability was suspected, as the author implied, it should not be forgotten that a number of environmental aberrations and difficulties were encountered when the herd size increased. Mr. Madden suspected that the evidence one so very often was presented with, where a more than expected proportion of cows appeared to come into oestrus on one day, might not be always indicative of an inability to detect oestrus reliably. More possibly, the cows were showing, owing to some weak hormonal state, psychological oestrus, stimulated by the occasional truly bulling animal.

He endorsed the author's findings concerning the very low conception rates obtained when insemination was carried out before the uterus had involuted within 40 to 50 days of calving. He was surprised, however, that the figures quoted in the paper were those published 8 years ago in the Milk Marketing Board Production Report. Their meaning had been substantiated elsewhere in the world, but whilst such small populations were quoted, a number of

influential workers still advised breeding to an earlier heat. General practitioners could help in denying that doctrine, preventing a farmer who was worried about the calving interval from breeding too early and exaggerating the spiral of lowered fertility. Top fertility was only to be experienced if insemination was withheld until about 70 to 90 days after parturition.

Another management factor affecting fertility was that of inseminating at apparent heats too closely following the first insemination. A 90- to 120-day conception rate of 48 per cent. was experienced in over a thousand such inseminations where the interval was 10 days or less. A farmer would be well advised to wait for the cycle to settle and have a repeat insemination when the second apparent return to oestrus occurred at a more normal interval after the preceding one.

The effect of season on fertility had been a widely discussed one and tended to become an excuse for variations experienced. He had no doubt that in individual herd circumstances that was so but, broadly speaking, he could support the author's contention that no differences were noted throughout the year. It would be of interest to know whether, in Table 6, the figures quoted included only semen used on the day of collection. It was Mr. Madden's experience, admittedly with smaller populations, that when the results from semen older than 24 hours were separated from those obtained with fresh semen, there was a slight rise in conception rates during the winter months. He attributed that somewhat cynically to the probable increase in anoestrus at that time.

Mention had been made of frozen semen, undoubtedly the greatest technological advance of the decade in A.I. work, discovered by Polge and others. The exploitation of that technique by the Milk Marketing Board had been disappointing, but must have been fraught with difficulty in organising the service. It was justifiable criticism on the part of farmers who paid a special and not inconsiderable extra fee for nominating a bull with much poorer chances of successful fertility levels than if he took the normal semen of the day. The nominated service on 2,489 first services provided by the Hampshire Cattle Breeders Society last year produced a 90- to 120-day conception rate of 61 per cent. That obtained from 318 imported doses resulted in only 49 per cent. holding.

Incidentally, stricter attention to the individual ampoule of frozen semen processed, cutting down variability in batches, had, together with the development of a technique of freezing on the day of collection, apparently lifted the Hampshire Cattle Breeders Society frozen semen rate on 4,254 first services to 64 per cent. That figure was obtained using bulls unselected for their freezing capabilities.

Short of some oblique reference to the possibility of frozen semen processed by the Milk Marketing Board being implicated, he could not support the author's suggestion that the A.I. laboratory might be involved in herd infertility problems. Most A.I. centres worked on a day-to-day basis and whereas he could not say that their techniques were infallible, the production of a herd problem by the laboratory would have to rely on an extraordinary combination of coincidences, such as the majority of cows in the herd being inseminated on one of the rare occasional days when the diluent was attenuative.

One of the most intriguing parts of the paper concerned the data he presented in Tables 8 and 9, dealing with the Ministry licensing of bulls for use in A.I. Centres and the subsequent reasons for disposal. There were several interesting factors about which the author might enlarge and comment. In 1956, 24 per cent. of the first examinations were rejected on livestock grounds. In 1957, 21 per cent. and in 1958 only 18 per cent. were rejected. With re-examinations only 6 per cent. were rejected. Was that indicative of the judgment on the part of the Livestock Division becoming more tolerant as time went by? Could it be that it was being recognised that personal opinion played a considerable part in the assessment and that animals were rejected somewhat wantonly? It would be interesting to know what percentage of the rejections on livestock grounds the Milk Marketing Board submitted for re-examination.

If the rejections by the Animal Health Divisions were examined, it would be noted that there was also a decrease from 25 to 20 per cent. of rejections in the years surveyed. Perhaps, having set a high standard initially, it was now possible that it was recognised that good fertility might be supported by semen of less restricted standards. It was equally evident from the data given concerning re-examinations that the Animal Health tests were more factual than the Livestock Division's criteria, 30 per cent. of the re-examinations failing again. Again, it would be interesting to know whether the author could supply the percentage of rejections on Animal Health grounds which subsequently passed those standards.

Concerning the reasons for disposal of bulls from A.I. Centres given in Table 9, the author refrained from attempting to comment on the possible tie-up with the data concerning bull testing in Table 8. It would be interesting to know whether the majority of the 102 bulls disposed of comprised bulls which had passed their A.I. licensing requirements impeccably, or whether they were the ones which had been rejected and only admitted upon re-examination. He asked the author whether he could not only give that information but, in particular, separated to provide, say, the percentage of the 30 disposals grouped under reproductive failure which failed at their initial examination for A.I. licensing. Information concerning that would be invaluable to those providing the licensing standards and applying the tests in order that they could determine the reliability of their requirements. It would also be interesting to know what period Figure 9 covered and if it represented only a year or so to suggest that the data for other years could be added with benefit.

With regard to Figure 10 and the author's comments concerning the insurance scheme, Mr. Madden was surprised at the number of mechanical abortions. Had the Milk Marketing Board adopted the technique of insemination only just within the cervix for repeat inseminations as distinct from depositing the semen at the cornual bifurcation and still suffered those losses? When liability was admitted for mismarked calves, it did seem surprising that a farmer was allowed to "cash in" on the human errors of an organisation which did so much to maintain the economic stability of the dairy industry as a whole. After all, it was more than a suspicion that many animals were in calf to a previous insemination. The abortion rate quoted did not represent that proportion, as many practitioners would be able to substantiate when, to their horror in days gone by, they injected far more violent potions than another 1 c.c. of diluted semen into the uterus of a pregnant animal without aborting the animal. Was that not a situation where good will should be manifested on both sides of the A.I. industry. The percentage of mismarked calves was so small that it would hardly equal the percentage of registrations faithfully recorded in herd books, which calves had, in fact, resulted from a previous service. A field project to detect statistically the percentage that occurred in that way was at present being carried out by the Hampshire Cattle Breeders Society in conjunction with Dr. Hall's blood typing research laboratory at the Animal Breeding Research Organisation, Edinburgh.

In conclusion, Mr. Madden made the following plea for the future: (1) That selection of animals should be made for one factor only—productivity. (2) That record keeping should be made comprehensive yet flexible so that reliable data over large populations might be made more readily available. (3) That publicity be given to faults which came to light so that benefit might ensue from the experience. (4) That breeding organisations took a positive view and gave a lead in policy guidance to farmers. By his training, a veterinary surgeon's field of operations was peculiarly adapted to be at the very meeting point of a number of other different specialist lines, and it fell to him the considerable responsibility of amalgamating breeding theory and farming practice. In him alone lay the capability of creating the blend upon which future progress would depend.

Mr. J. W. Bruford, the joint opener of the discussion, said he must comment first on the author's statement that livestock improvement was the primary object of A.I. and

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that everything else connected with it was of secondary importance. It was indeed difficult to place in their correct sequence the factors which had done so much to improve the productivity of livestock, and no doubt that sequence would be varied according to the interests of the speaker. For instance, he remembered well the days when tuberculosis and brucellosis caused incalculable losses. If those diseases had not been controlled would half the benefit have been derived that had been derived from improved pastures, general management, pedigree breeding, milk recording, etc.? All those things had no doubt had a great influence on livestock improvement and, although he did not wish to underrate the part that A.I. had played, he felt that the hopes which were entertained in the early days on the benefit which would follow the widespread use of high quality bulls would appear now to have been rather optimistic.

It seemed also that to get cows in calf and to maintain a service using semen of high fertilising ability should be of paramount importance and not, as the author suggested, secondary to livestock improvement. Those two objects need not, of course, be antagonistic.

The bulk of the paper discussed several factors which might influence the over-all conception rate at an A.I. centre, and the author made it quite clear that his investigations led him to suspect, among other things, that practising veterinary surgeons did not pay sufficient attention to "management infertility" when they were investigating the cause of a low conception rate in a herd. Mr. Bruford said he was acutely aware, as a practising veterinary surgeon, of the difficulties encountered in the field of infertility, and he wished the author had been a little more explicit in his use of the term "management infertility." Perhaps the author would define his use of the terms "management infertility," "breeding management" and "service management." It would also be interesting if he would elaborate on his reference to "observation of heat in detail." If one's interpretation of those terms were correct, then the author was probably referring to recording by the herdsman of details such as dates of calving, oestrus and inseminations. There was no doubt that attention to those details could make quite a difference to the conception rate in a herd.

It was the practice in several pedigree herds to require the herdsman to keep proper records in a large indexed book, giving space for at least a page per animal, where every possible piece of information about the animal with regard to its health was kept from birth. Mr. Bruford suggested that particular attention was paid to signs of oestrus in maiden heifers and cows and the recording of those heats several weeks before they were required for service. Details of all advice and treatment with particular attention to breeding difficulties were kept in the book, and it was believed that it was well worth while and was what the author probably meant by breeding management.

Mr. Bruford had investigated many herd infertility problems and had received a great deal of help from other workers experienced in that field. Many hours of hard work had gone into studying herd records, service dates, etc. He had taken innumerable samples to eliminate infectious or contagious disease and much time had been spent going into the complete analysis of feeding and possible nutritional factors, and yet he had never satisfied himself that he had put his finger on the trouble except when Brucella infection had clearly been present, or when the fertility of the bull had been suspect. He had found, however, that in most of those problem herds the position had been improved, taking the calving index as the yardstick, when more accurate information had been kept on the farm and closer attention paid to the details of breeding managment. He appreciated that his own practice in many other respects was supposed to be quite different from those of other practitioners in the country, but he personally had never satisfied himself that he had seen an outbreak of Vibrio infection in any of his herds.

It must not be assumed from what he had just said that he would not at the same time take all possible steps, when investigating a poor conception rate in a herd using natural service or A.I., to eliminate the possibility of any known infectious or contagious disease. Any practising veterinary surgeon would be failing in his duty if he did not attempt to eliminate possible brucellosis or Vibrio infection. The author implied in his paper that when infertility arose in a herd using A.I. the blame could usually be laid at the door of the farmer, his stockman or his veterinary surgeon. Could one then take it that the author believed that A.I. had never been responsible for an infertility problem in a herd?

Mr. Bruford was surprised that so little mention had been made in the paper of deep frozen semen, and it would be appreciated if the author would enlarge on the reasons for the apparent lack of enthusiasm for that method of A.I. The process of deep freezing semen was simple enough, and one would have thought that having a bank of deep frozen semen from proven sires of known fertilising ability would have been a most comforting thought to those in charge of an A.I. centre or to anyone investigating a herd infertility problem.

During the past 3½ years his concern had provided an insemination service for several clients using deep frozen semen. That semen had been collected, processed, stored and inseminated by themselves. The greatest possible care was taken in the collection and processing of that semen. In his experience samples of semen from the same bull might vary quite widely. The best samples appeared to be obtained if the bull was properly prepared by adequate fasting and teasing. It was found that the estimation of the value of the semen based on motility and wave movement also varied unless care was taken in the preparation of the slide. It was believed that no time should be lost between collection and examination, and it was important to examine the slide on the farm on a heated stage which might be done by placing the slide on a bottle of warm water on the microscope stage. The examination of a stained slide could be carried out later.

He had been asked by clients to provide that service for a variety of reasons which might be of interest. They were (1) To enable a farmer having two or more farms to use his bulls on any of the cows without the necessity of transporting either the cow or the bull. (2) Insurance against death. (3) Control of suspected venereal infection. (4) Pending incapacity due to lameness or other injury. (5) The desire to use old and heavy bulls on young heifers. (6) Temporary inability to serve, and that included those bulls said to be unable to reach the cow naturally which, it was believed, was usually due to overweight. (7) Disposal by sale of a bull whose breeding value was established or was still in doubt. (8) For the sale of semen to herds situated in other parts of the country. (An Article 3 licence was required for that.) (9) Johne's disease control. In two cases a valuable bull was seriously affected with Johne's disease. (10) In one case semen stored from a 10-month-old bull in order that he could be used on adults to assess his genetic value a year earlier than would otherwise have been possible. The same farmer had asked for that to be done again this year and, although the numbers were very small, the conception rate from that young bull was quite fantastic —nearly 100 per cent.

In most of the herds the conception rate to the deep frozen semen had been extremely good, although it must be said that the numbers were comparatively small. Nevertheless, the owners were satisfied that the results were comparable with natural services.

Last year there was an opportunity to test out the fertilising ability of deep frozen semen processed by his concern against natural service in a bunch of maiden heifers. That small trial was as follows: 46 maiden heifers had been reared on the same farm and were running in 3 semi-covered yards for the winter. Twenty-three heifers were served naturally by one bull which was not running with the heifers and it took 32 services to get them all in calf. The other 23 heifers were inseminated by deep frozen semen from 3 bulls on the farm. It took 33 inseminations to get 22 heifers in calf, one failing to breed either to natural service or to A.I. The only selection between the two groups was dictated by the owners' desire to use particular bulls on particular heifers.

The herd of which those heifers formed a part comprised

about 350 head of stock on 6 farms under the same ownership. With the exception of the small trial described, all breeding in the herd for the last 3½ years had been carried out using deep frozen semen, the conception rate being 60 per cent.

That herd contained several very old cows which tended to wreck any conception rate, for some of them just would not breed again. In pedigree herds, however, those animals were often regarded as potentially valuable breeders. He had little doubt that they pulled down the conception rate to no small extent.

Although it was maintained that the conception rate was 60 per cent., the farmer worked it out at 71 per cent., but he had probably taken out some of the cows which were empty when a start was made at the beginning of the year and were still empty at the end of the year.

In most of the other herds the numbers tested were small; nevertheless they gave good grounds for the belief that if the semen were of good fertilising quality, the process of deep freezing gave results comparable with other methods of storage. Mr. Bruford had semen which was 3½ years old and which was still getting cows in calf and apparently had not deteriorated.

So far as he was aware there were few other practices in which that service was being rendered. It might be that he and his colleagues had been fortunate in having available an intelligent and willing lay staff to whom he was greatly indebted, and in consequence had been able to take that additional work in their stride. The clients were well satisfied and had been very well pleased with the conception rate obtained. It had meant, of course, that close contact had been kept with the herds, and he felt sure that it had been of great value in maintaining their breeding capacity.

In conclusion he was greatly indebted to Mr. Stewart and his colleague, Mr. Bruce, of the Ministry of Agriculture A.I. Centre at Reading, for much helpful advice on the method of collection, processing and storage.

The General Discussion

Mr. E. Conn (Stormont): "Due to the tremendous development in A.I. there is room for thought as to whether the veterinary surgeon is being used to the maximum: I am referring, of course, to the rôle of the veterinary surgeon permanently engaged in A.I. I consider that the country is inadequately covered by veterinary surgeons. In Northern Ireland there is a veterinary surgeon at each bull centre and a veterinary surgeon to every two sub-centres, and consequently there is close co-operation between the veterinarian and the herd owner. I am confident that this system has much to commend it.

"Does Mr. Smith consider that all female offspring should be identified to enable a good cross-section opinion to be obtained as to the genetic value of bulls? Could Mr. Smith give some details of disease control measures at the bull studs, and are separate records kept of maiden heifers? In Northern Ireland a lethal factor has recently been found in certain eggs and I wonder if Mr. Smith could give his views on the matter and tell the meeting if he has experienced such a factor?"

Mr. W. K. Hunter (Milk Marketing Board, Middleton): "I should like to enlarge upon several points mentioned in Mr. Smith's paper, and which have arisen in the discussion.

"The question of demand for service too soon after calving is tied up with economics. On occasion a farmer may be attempting to make up for time lost in a previous lactation, and secondly, from his point of view, it costs him no more as his normal fee covers him for the first service and as many repeat services as he may care to demand. On the other hand, it is costly to the A.I. movement as the conception rate is low to services asked for too soon after calving.

"Regarding the validity of the assumed conception rate, I believe that it is most reliable. I readily concede it is not 100 per cent. reliable, but am certain that the reliability is within the region of 94 per cent. to 95 per cent. In the Northern Region of England we have found this to be so in the first 5 years we have been co-operating with the A.R.C. and research organisations to find calves for progeny testing. Our method has been to consult our herd record cards and list the cows assumed to calve around the desired date for the commencement of the progeny test, our aim being to find groups of calves born as near to one date as possible. About 3 weeks before the chosen calving date visits are made to the owners of the cows and their agreement sought for purchase of the calves. We have found that 96 per cent. of cows assumed to be in calf are in calf. The total number of cows involved over the period was approximately 800. However, we did find that 6 per cent. of cows were in calf to an earlier service than that which we had assumed. This figure of 6 per cent. was also borne out by statistics kept for some 2,600 pedigree cows when it was found that the final certificate for 6 per cent. had to be cancelled as the cows had calved to an earlier insemination.

"Mr. Bruford mentioned *Vibrio fetus* and it might be of interest that, at a progeny testing station where, in the past 5 years, 300 heifers have been collected from all over England and Wales, all of these animals have been negative to the mucin agglutination test for *Vibrio fetus*.

"On bull semen evaluation I consider that the broad bulking of semen pictures into one for beef breeds and another for dairy breeds is wrong. Broadly speaking there is undoubtedly a semen picture which is standard for each breed, and I am certain that that is as far as classification should go. Examples are the Jersey breed which has a high laboratory standard, but is amongst the lowest of conception rates. The Dairy Shorthorn has a much poorer standard than the Jersey, but yet has a high conception rate.

"To turn to the beef breeds, the Beef Shorthorn has the poorest picture and yet is very fertile. I had not much experience of Beef Shorthorns, until it was my sorry lot recently to examine some. I was most despondent until I had contacted colleagues in Scotland, and they assured me that what I had considered to be poor producers were, in fact, excellent for the breed. Laboratory standards are only of real value when these can be linked to known conception rates attained in the field, and to the quality of semen used.

"Mr. Conn posed the question of difficulty in starting off young Aberdeen Angus bulls. That, too, has been our experience, but is of a transitory nature. We should remember that the aim of Aberdeen Angus breeders is to produce a superbly fleshed animal demonstrating fleshing potential and early maturity, resulting in a deep-barrelled animal with short legs. This animal has resulted from being reared in an asexual atmosphere; suckled on foster-cows, which are settled in calf as early as possible; fed succulent food at frequent intervals and housed separately. In fact every step is taken to suppress sexual instincts which would interfere with the attainment of condition. The process of conditioning a young bull for use in artificial insemination is often a slow job calling for great patience, but once the puppy-fat has been removed and time allowed for the slow build-up of libido, the Angus bulls settle down to their work and are most reliable.

"As for difficulty with egg-yolk citrate buffer, Mr. Conn might find heat treatment of the prepared diluent prior to the addition of semen of value."

Mr. S. Jennings (Glasgow): "Mr. Smith has stated that the primary object of an A.I. programme is one of livestock improvement, and Mr. Madden has stated that A.I. has failed miserably in achieving this objective. It is not known if Mr. Smith agrees with Mr. Madden's view but if there has been a failure in the past then there is no need for pessimism. None will deny the improvement in small dairy herds, but in the over-all picture the breeding of bulls is the same to-day as it was before the days of A.I. in that the breeding of bulls is carried out for the most part by those who do not use A.I. Or is this not the case? Can Mr. Smith tell us if most of the bulls at centres are in fact produced themselves by A.I.?

"The use of deep freeze semen and progeny testing are comparatively new innovations and with the extension of these aids there is surely cause for optimism for the future."

Mr. T. S. Anderson (Altrincham). "A.I. is of marked benefit in that it cuts down disease, and saves the small farmer the necessity of keeping a bull. Can Mr. Smith

state with certainty that venereal disease is not spread by A.I.?"

Mr. H. F. Hebeler (Langport): "Mr. Bruford has stated that he has never connected *V. fetus* infection with a herd infertility problem. I suggest that he has been very lucky since a very large number of practising veterinary surgeons up and down the country have been able to connect positive mucin agglutination test results with a herd infertility problem. I am not suggesting, from my own experience, that this is associated with the practice of A.I. but to ignore that it could be would be to blind oneself to the fact that it has been amply proved to be spread by venereal contact."

The Replies

Mr. J. W. Bruford, in reply, referred to the question of *Vibrio fetus* infection, and repeated that he had not seen an outbreak in his practice. He did not suggest that it was not a pathogenic problem or that there were not serious infertility problems due to that parasite. He was glad that he had made that statement, because in his view the position had been made quite clear by the Director at Weybridge.

In regard to another question, the infertility that Mr. Bruford had seen associated with brucellosis was following a high percentage of abortion, and the cows required repeated services to get them into calf. That was the total picture. Vaccination had in fact been practised in that herd, but whether or not all the animals had been vaccinated he could not say. He would imagine that some of them had not been vaccinated although the owner thought that they had been.

Mr. G. F. Smith, in reply, said that so far as the substance of his contribution was concerned, he desired it to be taken as a collection of facts or material through the whole organisation and all his colleagues; in fact, the whole of the A.I. movement, rather than from one section, namely, the Milk Marketing Board.

He had been taken to task by speakers for omissions from the paper. With regard to Table 6 referring to the conception rate, his organisation did not use first-day semen for the entire operation. Somewhere in the region of 70 per cent. of the semen produced might be used on the first day, but a big proportion did in fact get used on day plus one.

It might be true to some extent that oestrus in winter time inflated the conception rates, but Mr. Hunter's remarks in that respect clarified the position. A certain number of cattle might be disposed of after a single insemination but, after all, conception rate was only a paper efficiency figure. Provided all used the same measure, however, it was possible to draw one's own conclusions as to the general fertility data.

Mr. Madden mentioned the frozen semen programme as practised by the Hampshire Cattle Breeders, and the author desired to compliment Mr. Madden and the Hampshire Cattle Breeders on their advances in that field.

It would probably be true to say that a single centre was in a better position to organise a programme of that sort than, perhaps, the larger organisation. The technical efficiency of the programme had to be tried. The equipment had to be available and, over and above that, the fact had to be appreciated that at the present time at least it was better perhaps to have genetically superior sires on service than to approach the use of frozen semen as an expedient in cutting down running expenditure and the number of bulls required in the organisation.

The quality of sires or cows being presented to the Ministry livestock officers was probably better than it was eight years ago when artificial insemination was in its infancy. A considerable distance had been travelled during that time, and without doubt that was reflected in the material which was now becoming available for inspection.

The number of bulls which the Ministry were asked to retest or to reinspect was interesting.

With regard to fertility examinations, there always was a controversy on examining young bulls, and by collaboration and discussion the Ministry had considered it reasonable that they did not pass judgment on the semen of bulls under fourteen months of age. That had probably helped the situation. It had avoided some of the criticism of the past and had helped within the industry to take advantage of more bulls than would otherwise have been the case.

Reference was made to semen produced by the younger bulls being brought in. The author and his colleagues did run a progeny testing scheme and found that very few of the young bulls which came in were in fact thrown out for fertility reasons. Something in the region of 4 or 5 per cent. were lost for poor semen production.

With regard to the question of mismarked calves, the weakness of any scheme which opened itself to abuse by unscrupulous individuals was known. He believed that if one desired to be dishonest it was only a question of cheating oneself indirectly for, after all, most animals giving semen in this country were producer-owned. He honestly believed that there were few people who would go out of their way to substitute cows.

Mr. Bruford did the right thing to put the question of livestock improvement into its true perspective. With regard to the points made on infertility and breed management, the author's view was that the system which was described would make a great contribution if one could get the practitioner sufficiently interested to get it available.

The part breed societies played in A.I. development varied, however, but collaboration on all sides had resulted in many useful contributions having been made by them to the cause of livestock improvement.

As to the identity of animals in progeny testing work, they were cattle under the official milk recording scheme and were pedigree..

In reply to Mr. Jennings, a certain number of young bulls came from the sales and a large number of direct offers came from breeders; but it was becoming increasingly evident that with the contemporary comparison of sire selection, a number of offers were coming from breeders of bulls which were in fact top by our top sires, and there was also what was called a "planned mating test."

With regard to Mr. Anderson's comment in respect of the use of artificial insemination, in the author's view there was too much modesty in that respect. There was a desire not to plug the fact that a valuable service was being given to the man who would be otherwise in trouble.

In reply to Dr. Stableforth, on looking through the literature on *Vibrio fetus* infection it was difficult to obtain information on a truly-well-planned incidence study. It was therefore difficult to know what effect therapeutic measures had had on a condition if figures before and after such intervention were not available, especially having in mind the fact that conception rates remain so satisfactory.

Dr. A. W. Stableforth (Weybridge): "Since the subject of vibriosis has been raised there are certain things that ought to be said. There is in my opinion no doubt that it has now ceased to be an important national problem. All the bulls in the A.I. Centres have either been treated for diagnosed *Vibrio fetus* infection or have received 'lavage.' Since about 90 per cent. of infections are sterilised in this way and since the semen is then used with antibiotics which also reduce infection by about 80 to 90 per cent., the likelihood of infection being transmitted has been reduced to a low level; and when it is remembered that in a herd in which A.I. only is used the infection cannot be spread within the herd and that the inseminated animals may in fact be resistant, it is not difficult to understand why the problem has ceased to be of national importance.

"We must not allow this, however, to blind us to the fact that *V. fetus* is a primary pathogen and has been spread by A.I. If proper preventive measures had not been taken the position would now have been very different.

"It was shown in the first place that there existed in Holland and in Great Britain a venereally transmitted form of infertility. It was subsequently shown in Great Britain and elsewhere that this was associated with *V. fetus*. In their own experiments they used an infected bull to serve or artificially inseminate a group of virgin heifers and used a clean bull to serve or artificially inseminate a comparable group of heifers from the same source. The numbers of services per conception (or final calving) in the heifers served or artificially inseminated from the infected bull were 2 to 3 times greater than in the heifers served or

inseminated from the clean bull. It was also shown in the same group of experiments that the addition of pure cultures of *Vibrio fetus* to the semen of the clean bull made this infective and reduced the conception rate, whilst a filtrate of the infected semen did not infect. Moreover, other virgin heifers in adjoining stalls did not become infected and conceived normally. Results in line with these have been obtained in several subsequent experiments. They have also been obtained in other countries and there is now international agreement that *V. fetus* is pathogenic. Other factors might play a part in influencing the severity of the disease but none is needed. Whilst the problem has now been overcome in most western countries there are other countries in which it has not, and it would be wrong to allow any statement that *Vibrio fetus* was not pathogenic to go out from the meeting.

"Not only do the results of all the experiments we have done point to the same general conclusion as regards the pathogenicity of *Vibrio fetus*, but taken as a whole they are statistically quite unequivocal in showing that *Vibrio fetus* is a pathogen in its own right and that it can be spread by both natural service and artificial insemination with consequent infertility."

The Cystic Hyperplasia-Pyometra Complex in the Bitch

BY

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THE commonest form of endometritis in the bitch is the condition loosely described as pyometra. Though the term denotes an accumulation of pus in the uterus, it is used to describe a post-oestral syndrome of the adult bitch associated with a variety of clinical and pathological manifestations of genital disease. The clinical disease varies greatly in severity and is influenced by a number of factors, probably the most important of which is the degree of patency of the cervix. Vulval discharge may be the only symptom observed in some cases in which the cervix is open. Where the cervical canal is occluded the animal is generally more seriously ill exhibiting anorexia, depression, abdominal distension, thirst and frequently vomiting. Discharge is slight or absent in such cases. There are rarely any marked histological differences between open and closed cases despite the obvious disparity in the size of the uteri. The commonest lesion is cystic glandular hyperplasia of the endometrium which can also be found in many older bitches without any evidence of pyometra. Because of this association between cystic glandular hyperplasia and endometritis, I have described the entire range of lesions under the broad term of the cystic hyperplasia-pyometra complex.

This communication is based on the clinical and pathological examination of 172 bitches of which 119 were presented as clinical cases of genital disease and the remainder were found in a survey carried out in the course of routine *post-mortem* examination of all bitches dying in the hospital. The series has been divided into 4 major groups on a histological basis. A summary of the experimental reproduction of the various forms of the disease is presented.

TABLE I
AGE INCIDENCE OF CASES OF THE CYSTIC HYPERPLASIA-PYOMETRA COMPLEX.

Age years	Group I	Group II	Group III	Group IV
3	1	0	1	0
4	4	1	2	0
5	5	2	5	0
6	8	4	9	1
7	6	5	10	0
8	9	4	14	1
9	3	2	10	3
10	5	1	12	4
11	4	2	5	5
12	3	1	3	4
13	2	0	4	1
14	1	0	1	1
15	1	0	0	1
16	1	0	0	0

Group I

A survey of the genitalia of 400 bitches submitted to routine *post-mortem* examination revealed cystic glandular hyperplasia of the endometrium without any superimposed inflammatory reaction in 53 cases. These uteri were generally larger and more rounded than normal. The thickened endometrium was lined by a variable number of thin-walled, translucent cysts of up to 1, and occasionally, 2 cm. in diameter. The cysts were evenly distributed throughout the length of the horns in most cases but they were more prominent in the upper ends of the horns in a few cases.

Escherichia coli was isolated from the uterine mucus of 9 of the 27 cases which were in metoestrus; bacteria were absent in all the others.

The histological picture varies to a slight extent with the stage of cycle, but an absolute increase in the number of glandular elements in all strata of the endometrium is constantly found. Whereas in the normal endometrium there is a striking uniformity in the size and configuration of the glands, in cystic glandular hyperplasia there is marked disparity. Some glands are large and cystic whilst others in the immediate vicinity are small and apparently normal.

The animals ranged from 3 to 16 years of age with a mean of 8.1 ± 3.1 years. Hyperplastic changes were not found in the uteri of any of the animals under 3 years of age which were examined in the survey. Cystic glandular hyperplasia was found in 17 per cent. of all animals over 5 years old whereas only 4 per cent. of those under 5 years were affected. Forty-one of the affected bitches were nulliparous and the other 12 had whelped from 3 to 11 years prior to examination. The survey included 238 maiden bitches therefore 16 per cent. of the nulliparous animals were affected as against $7\frac{1}{2}$ per cent. of the parous animals. Cystic glandular hyperplasia was found in only 3 of the 37 multiparous bitches examined. It is evident that cystic glandular hyperplasia is not a cyclic phenomenon since the lesion was found in animals at every stage of the oestrous cycle.

It was ascertained that 23 of these animals had shown some evidence of sexual abnormality during the years immediately prior to death. Irregular occurrence of oestrus had been noted in 8 bitches over a period of 1 to 5 years. The interval between any 2 consecutive oestrous periods had ranged from 3 to 10 months but in no case had this interval been consistent over a number of cycles. In 8 animals there had been abnormal duration of

oestrus which had been prolonged to 30 days or more or abbreviated to as little as 5 days. Bleeding persisted throughout pro-oestrus and oestrus in some cases whilst, in others, the only evidence of sexual activity was slight vulval oedema and attraction for males. Phantom pregnancy had been observed in 7 animals. The significance of these oestral abnormalities is doubtful since similar aberrations from the accepted normal were found in 19 of 53 unaffected bitches with the same age range and breeding histories. Only 1 of the normal group had shown evidence of phantom pregnancy.

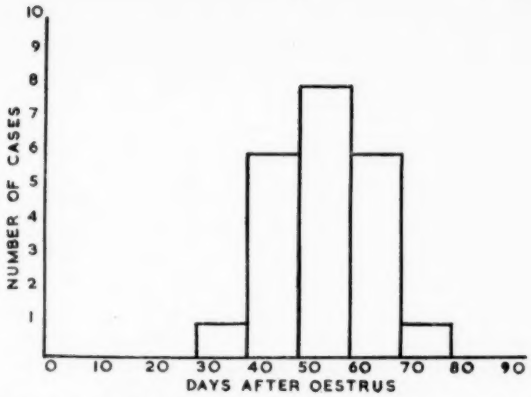
Symptoms of genital disease were absent in every case though a slight mucoid vulval discharge was apparent in a few of the cases which were in metoestrus. Examination of vaginal smears revealed differential cell counts which were consistent with the estimated stage of cycle except in a few anoestrous animals which gave smears suggestive of early pro-oestrus. It seems probable that these animals were coming into pro-oestrus before the expected time. Haematological examination failed to reveal any relevant changes in these animals. Uterine enlargement was detected in a few oestrous and metoestrous animals by radiography following artificial pneumoperitoneum.

Group II

There were 22 cases in this group in which the characteristic lesion is a diffuse plasma cell infiltration of the endometrium superimposed on cystic glandular hyperplasia. The uteri were thickened but the horns rarely exceeded 3 cm. in diameter. The hypertrophied uterine walls were lined by irregular cysts and polypoid ingrowths of the dull greyish, roughened endometrium. The cervix was commonly relaxed and patent. The uterine lumen contained only a few ml. of clear or pale red mucoid fluid. No bacterial growth was obtained from mucus samples from 4 of these uteri and 16 yielded *E. coli*. A coagulase-positive staphylococcus was obtained from the other 2 cases.

Histological examination of the uteri reveals a marked cystic glandular hyperplasia with diffuse infiltration of the endometrium by plasma cells which are concentrated in the crypt and inner tubular zones. In some cases where the cellular infiltration is widespread, plasma cells can be seen forming cuffs round the vessels of the inner myometrium and stratum vasculare. Evidence of tissue destruction, fibroblast activity and cellular exudation as seen in human plasma cell endometritis is generally absent.

The ages of the affected animals ranged from 4 to 12 years with a mean of 7.6 ± 2.2 years. Seventeen were maiden bitches and the other 5 had had single pregnancies between 5 and 9 years prior to examination. This lesion was found only in animals between 35 and 70 days after oestrus. Fourteen of them had shown irregularities in their oestrous cycles over periods of 1 to 3 years before onset of illness. Phantom pregnancy had been observed in 5 bitches.



GRAPH I.—Incidence of stage of cycle of cases of cystic glandular hyperplasia with superimposed plasma cell infiltration.

In most cases, the only symptom of note at presentation was a vulval discharge of glairy mucoid fluid varying from clear to dull red in colour. This discharge had been present for several weeks in most cases and many of the animals had shown evidence of malaise and anorexia at about the time the discharge first became apparent. Four of the animals had been ill during the first month after oestrus and had received some medicinal treatment at that time. Though they had improved considerably, the discharge had continued. Vulval oedema was common in this group but only 2 of the animals showed any degree of malaise when presented for treatment.

The epithelial cells present in the vaginal smears of these bitches were consistent with the animals being in metoestrus. A few neutrophils were present in some cases being most numerous in the 2 animals which had shown malaise and anorexia when admitted. Occasionally a few epithelial cells of endometrial origin were found in the smears.

A mild leucocytosis was present in most cases with total white cell counts of 12,000 to 15,000 per cu. mm. There was little change in the differential white cell counts and no evidence of anaemia in any case.

Group III

The characteristic lesion found in 76 of the 119 clinical cases was an acute inflammatory reaction in an endometrium exhibiting a variable degree of cystic glandular hyperplasia. The size of the uterus was inversely proportional to the degree of patency of the cervix. Uteri weighing up to 3 or 4 kg., and with horns measuring up to 50 cm. in length and up to 8 cm. in diameter were not uncommon in 15- to 20-kg. bitches. The horns were of almost uniform diameter throughout their length in some cases, but more frequently they exhibited a number of annular constrictions producing a series of irregular ampullae. Unilateral distension was present in 3 cases; the contralateral horn was lined by a number of cysts but there was no evidence of

pus. The uterine fluid varied greatly in colour and in viscosity in the different cases. In many specimens it consisted of a thick yellow or green muco-pus whilst in others it was a thin, watery, reddish-brown often containing small blood clots. Thick muco-pus was commonest in those cases where the cervix was relaxed. It was impossible to pass a 3 mm. probe through the cervix in 11 cases and in many others the orifice was only slightly larger. The endometrium had a roughened appearance with mingling of smooth, pus-filled cysts, focal haemorrhages and areas of ulceration. Massive haemorrhage was not observed in any of these cases. Fluid retention was not due to blockage of the cervix by tumour in any of the cases examined.

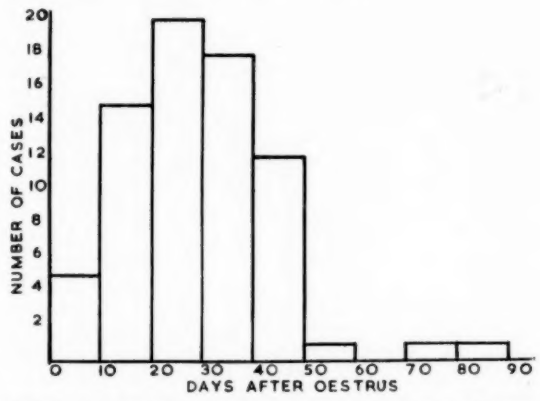
Only 7 cases failed to yield organisms on cultural examination of the uterine fluid. All but 8 yielded *E. coli*, 8 yielded a coagulase-positive staphylococcus and 7 yielded a β-haemolytic streptococcus. It is important to note that organisms were cultured from 9 of those cases with closed cervices and from 2 of the unilateral cases.

Histologically, there is an acute endometritis characterised by congestion, oedema and infiltration by neutrophils. In the milder cases the neutrophils are largely confined to the superficial half of the endometrium. The reaction extends into the deeper layers of the endometrium in the more severe cases and abscesses are formed around blocked glands. Ulceration occurs in many of the more severely affected uteri. The inflammatory reaction has spread to involve the myometrium in over 40 per cent. of the uteri examined. There was complete perforation of the uterine wall in one case which died of an acute peritonitis.

The members of this group ranged from 3 to 14 years with a mean age of 8.3 ± 2.3 years. Of the 76 animals in the group, 61 were nulliparous and 12 had whelped between 3 and 11 years prior to the onset of illness. Only 4 were multipara; 3 had whelped twice and the fourth had whelped 4 times. No oestral or breeding history was obtained in 3 cases.

The mean interval between oestrus and examination was 30 ± 13 days and though the range was 5 to 85 days, it is significant that 78 per cent. of the animals were presented for treatment in the first 40 days after oestrus. Twenty-one bitches had previously shown abnormalities in the duration of oestrus or in the interval between oestrous periods. Phantom pregnancy had been observed at least once in each of 7 bitches. There was a history suggestive of previous uterine disease in 9 cases.

The duration of the presenting illness was commonly from 4 to 14 days though in some cases some degree of illness had been present for a period of several weeks. In those cases of longer duration the illness had been of a low-grade type with periodic exacerbations. Vulval oedema was an almost constant finding being most prominent in cases in early metoestrus and in those of longer duration. Vulval discharge was visible in only 52 cases at first examination but appeared in a further 7 while awaiting surgical treatment. It was ascertained that discharge had been intermittent in almost one-third of these animals. Several had never discharged, whilst others had discharged for a few days at the start of the illness and had then ceased with subsequent exacerbation of symptoms. The volume of the discharge ranged from only a few drops on the lips of the vulva to an almost continuous flow. Listlessness and some degree of inappetence were apparent in all but 4 cases which showed little systemic upset. Increased thirst had been noted in 45 cases and 34 had vomited at some time during the course of the illness. Vomiting occurred in some cases only at the start of the illness and not thereafter. Vomiting was most frequent and most severe in the presence of gross abdominal distension. It is possible that vomiting in some of these cases was due in some part to a concurrent leptospiral nephritis since agglutination tests were frequently positive. Abdominal distension which was recognisable in 63 cases was usually accompanied by increased tension of the abdominal muscles except in prostrated animals. Diarrhoea was an infrequent symptom being present in only 5 cases. The body temperature was within normal limits in 59 cases, from 103° to 105° F. in 11 cases and under 100° F. in the other 6 cases. Subnormal temperatures were associated with a high operative mortality. The severity of the illness showed a direct correlation with the degree of uterine distension and with the extent of the involvement of the myometrium in the inflammatory process.



GRAPH II.—Incidence of stage of cycle in cases of acute endometritis.

Leucocyte counts ranged from 19,000 to 145,000 per cu. mm. The leucocyte count in closed cases was always over 40,000 per cu. mm., but very high counts were also present where there was a marked myometritis. The leucocytosis was always due to increase in the neutrophils, of which up to 35 per cent. were immature forms, mostly non-lobulated with a few myelocytes. In a number of cases with very high white cell counts, abnormalities were noted in the morphology of the neutrophils, particularly in the non-lobulated forms which exhibited cytoplasmic basophilia and occasionally cytoplasmic

vacuolation. There was a decrease in the number of neutrophil granules in many of the immature cells. There was no evidence of anaemia in any of the cases examined. The erythrocyte sedimentation rate ranged from 10 to 55 mm. per hour; rates of over 30 mm. per hour were associated with high mortality or slow post-operative recovery.

The plasma urea levels ranged from 21 to 180 mg. per 100 ml. with a mean of 38 ± 11 mg. Levels of over 65 mg. per 100 ml. warranted a guarded prognosis and were poor surgical risks.

Though radiographical diagnosis was simple in most cases, the picture obtained in some cases with ampulla formation of the uterine horns closely resembled that seen in the normal animal in mid-gestation.

Large numbers of neutrophils were present in vaginal smears, particularly in the freely discharging animals. The vaginal epithelial cells were similar to those observed in normal metoestrus *i.e.* of the non-cornified variety.

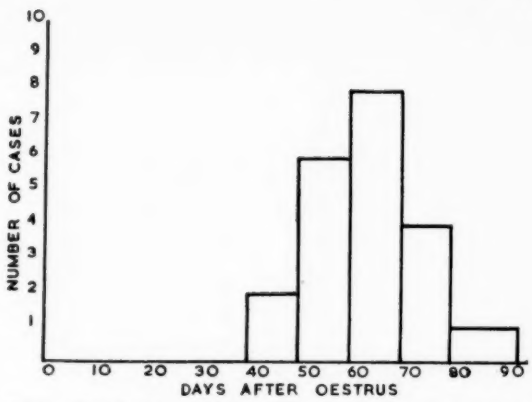
Group IV

There were 21 cases of chronic endometritis in the series. These cases were divided into 2 distinct clinical and pathological sub-groups according to the degree of patency of the cervix. The uterine horns were not greatly enlarged, the walls were thickened and the lumen contained only a small amount of muco-pus in those cases where the cervix was open. When there was cervical closure the uterus was commonly extremely distended and the walls were of paper-thinness. The fluid in these distended cases ranged from watery consistency to thick yellowish muco-pus. There was considerable haemorrhage into the uterine lumen in one case.

Histological examination of the closed cases reveals marked atrophy of the endometrium so that in many parts, only a few collagen fibres separate the myometrum from the surface epithelium of the endometrium. Glands are rare though a few may be seen penetrating the myometrium which is atrophic with elongation of the muscle fibres and loss of staining affinity. The endometrium shows infiltration by lymphocytes and a few plasma cells. The superficial epithelium shows evidence of squamous metaplasia in many cases. In the open cases, there is commonly considerable myometrial hypertrophy and fibrosis. The endometrium is atrophied and infiltrated by lymphocytes and occasional plasma cells. A few isolated cysts may be seen in both types.

Bacteriological examination revealed no organisms in 2 cases, *E. coli* in 16, *Staphylococcus aureus* in 5 and a β-haemolytic streptococcus in 3 cases.

The mean age of the animals was 10.6 ± 2 years and though the range was from 6 to 15 years, only 2 cases were under 9 years of age. Only 3 out of 19 bitches had been pregnant; change of ownership rendered data incomplete in the other 2 animals. Two had whelped twice and the other 3 times during a period ending at least 5 years prior to examination.



GRAPH III.—Incidence of stage of cycle in cases of chronic endometritis.

All were presented in the period 40 to 90 days after oestrus (Graph III). There was a history of previous post-oestral genital disease in 16 cases. Phantom pregnancy had been observed in 4 cases.

The illness was commonly of several weeks duration, dating back to the previous oestrus in some cases. Clinical sub-division was clear-cut. The only symptoms observed in the open cases were vulval discharge and slight inappetence. Some had been more seriously ill at an earlier stage in the present cycle whilst others had discharged from the preceding oestrus without showing any marked discomfort. The closed cases were seriously ill and showed gross abdominal distension, increased thirst, frequent vomition and marked depression. Some of these had not discharged at any time during the present cycle whilst others had discharged until a short time prior to admission. There was no correlation between the severity of the illness and the age or the time after oestrus in either type. Skin lesions were common in both open and closed cases. The skin was generally dry and inelastic with areas of alopecia on the flanks, over the abdomen and on the perineal region.

Leucocyte counts ranged from 16,000 to 28,000 per cu. mm. in the open cases and from 31,000 to 84,000 per cu. mm. in the closed cases. The leucocytosis was due largely to neutrophilia, but in some cases bizarre mononuclears accounted for up to 8 per cent. of the total. These cells had irregularly stellate nuclei containing a small amount of chromatin arranged in a loose monocyte-like fashion. The cytoplasm was a dull blue with occasional vacuoles in it but no granules could be detected on supravital staining. Only one animal showed evidence of anaemia. The erythrocyte sedimentation rate ranged from 8 to 46 mm. per hour, being highest in the closed cases. Plasma urea levels ranged from 27 to 160 mg. per 100 ml. and were of prognostic value.

Examination of vaginal smears revealed large numbers of neutrophils in addition to the normal vaginal epithelial cells.

Ovary

Cystic glandular hyperplasia of the endometrium uncomplicated by inflammatory changes was found in bitches at all stages of the oestrous cycle and therefore it is not surprising that there is no consistent histological picture in the ovaries. The ovarian morphology was compatible with the estimated stage of cycle in the majority of cases. Corpora lutea were present in the ovaries of all but one of the clinical cases of endometritis. These corpora lutea appeared to be consistent with the estimated stage of cycle up to the fourth week of metoestrus but thereafter it was common to find corpora which had not undergone the expected degree of regression. These corpora lutea resembled those of pregnancy more closely than those of normal metoestrus in that the cytoplasmic lipid still formed discrete droplets and had not become confluent. This apparent persistence of luteal function was particularly common in cases in Group III and in some in Group IV. The morphology of the corpora lutea in Group II was generally more consistent with the estimated stage of cycle.

A wide variety of cysts and tumours were also found in the ovaries of the animals examined but there was no evidence that these abnormalities were more numerous in the cystic hyperplasia-pyometra complex than in a similar number of bitches of the same age group without uterine lesions.

Aetiology

This survey of the cystic hyperplasia-pyometra complex was undertaken so that a correlation of the clinical and histopathological findings might shed some light on the aetiology and pathogenesis of the disease. A number of factors common to all groups emerge:—

(a) The mean age of the 172 animals studied was 8.5 ± 2.8 years and though the range was from 3 to 16 years, it is significant that only 12 per cent. of them were under 6 years of age. This agrees with the findings of Benesch and Pommer (1930) and Hesselbarth (1937) who noted that the majority of their cases were between 7 and 10 years old. It is obvious that the cystic hyperplasia - pyometra complex is a disease of the older bitch though reports by Kammermann-Lüscher (1952) and others indicate that a syndrome which is at least clinically similar may be seen occasionally in 1-year-old bitches.

(b) It is significant that 78 per cent. of the animals in the series had never whelped and, presumably, had never been pregnant. Only 6 per cent. were multiparous. It may be inferred from this that absence of pregnancy is one of the underlying factors in the development of the disease. Benesch and Pommer (1930) supported this view and classified the condition as a disease of domestication because they found the condition more commonly in the urban household pet than in country dogs which were allowed to breed naturally.

(c) All clinical cases of endometritis were encountered in the period 5 to 90 days after oestrus, *i.e.* in the luteal phase of the cycle. This is supported by the finding of corpora lutea in the ovaries of all but one of the cases studied, and by the work of Kostner (1942) and Kammermann-Lüscher (1952) who also found corpora lutea in a very high percentage of pyometra cases. In addition, there is morphological evidence of delayed regression of the corpora in many cases of acute endometritis.

(d) It would appear that there is some relationship between the cystic hyperplasia-pyometra complex and phantom pregnancy since 23 out of the 172 animals examined had shown this phenomenon. Evidence of relationship with oestral irregularities is less convincing since a group of apparently normal bitches revealed a similar incidence of aberrations from the accepted normal.

(e) Bacteria were isolated from the uterine fluid in 89 per cent. of the clinical cases of endometritis. There was considerable variation in the type of organism found and none was specific for any one type of endometritis.

Early workers believed that pyometra was of bacterial origin. Infection was believed to occur at oestrus through the open cervix or during metoestrus by a retrograde lymphatic from the colon. It was also considered that venereal transmission might occur with subsequent foetal death producing an endometritis. As the number of organisms isolated increased it became evident that no aetiological specificity could be attached to any of them.

Final proof that bacteria were not the only factor involved in the pathogenesis of pyometra was afforded by the comparative failure of experiments to reproduce the disease by direct bacterial infection (Benesch & Pommer, 1930; Lesbouryies & Berthelon, 1935; Teunissen, 1938, and Kostner, 1942). Teunissen and Lesbouryies and Berthelon reported rare instances of organisms which would produce an endometritis but there was no associated hyperplastic reaction in the endometrium in either case.

The first indication of the nature of the other factors involved in the genesis of the cystic hyperplasia-pyometra complex was given by Lesbouryies and Berthelon (1935) who showed that the clinical disease could be cured by simple ovariectomy. The condition did not recur in animals so treated and these workers concluded that the disease was a manifestation of hormonal imbalance due to ovarian dysfunction.

Hetzel (1935) reported the production of a mild form of cystic glandular hyperplasia of the endometrium in spayed and in normal bitches using oestrone. He inferred from this that the natural condition in the bitch was due to hyperoestrinism. Since pyometra is the commonest complication of cystic hyperplasia he suggested that it was merely a further manifestation of hyperoestrinism. Hetzel's hypothesis received some support from Ajello (1948) who produced an inflammatory reaction in the endometrium of a 3-month old pup by oestrogen treatment but further experimental work by Teunissen (1952) and DeVita (1952) failed to

reproduce their findings. Teunissen has also shown that hyperplastic changes of the superficial zone of the endometrium may be produced by prolonged treatment with progesterone. He also obtained inflammatory lesions in 7 out of 15 bitches treated in this way.

Despite the lack of experimental corroboration and its incompatibility with present knowledge of the natural disease, Hetzel's hypothesis has dominated views on the aetiology of the cystic hyperplasia-pyometra complex since its publication.

Experimental Reproduction of the Cystic Hyperplasia-pyometra Complex

In the following experiments, healthy maiden bitches of 9 to 18 months were submitted to bilateral ovariectomy and rested for 4 weeks before commencing treatment. In addition to permitting complete recovery from operative interference, this interval allowed time for inactivation of endogenous ovarian hormones and for regression of the normal cyclic changes in the endometrium. Animals of this age were used because the survey indicated that they were unlikely to have any natural cystic changes.

In the first group of experiments, animals received daily injections of from 0.5 to 30 mg. of stilboestrol dipropionate or its oestrogenic equivalent of oestradiol monobenzoate for periods of 10 to 400 days. Doses of 5 mg. or more proved fatal in 11 to 45 days. The histological picture in animals treated for periods up to 60 days is that of oestrus or an exaggeration of it. There is only a slight increase in the number of glands present and little or no dilatation. After 120 days treatment there is little further proliferation of the glands and only a few show slight dilatation. The most prominent change is a general increase in the number and size of the collagen fibres present in all layers of the uterine wall. This increased collagen deposition becomes more marked as the treatment is prolonged and after 400 daily injections of 0.5 mg. of stilboestrol dipropionate there is complete fibrosis of the uterus. The glands show little or no activity in these cases and appear atrophic.

In the second group of experiments animals were administered 10 mg. of progesterone per day by intramuscular injection for periods ranging from 10 to 60 days. Half of them received 10 daily injections of 5 mg. of stilboestrol dipropionate daily before commencing progesterone treatment. All these animals remained healthy throughout the duration of the experiment. The endometrial changes during the first 20 days of treatment were very similar to those of normal metoestrus. After 40 days this similarity had disappeared and cystic changes were present in the crypt and tubular zones of the endometrium. After 60 days' treatment, there was a distinct cystic glandular hyperplasia of the endometrium resembling that seen in the natural disease. These changes were more marked in those animals which received preliminary oestrogen treatment. If the progesterone dose was increased to 25 to 50 mg. per day, there was no evidence of enhancement of the cystic process by oestrogenic sensitisation. Small foci of neutrophils were occasionally seen in the endometrium of some of these cases but there was no evidence of an endometritis.

In an attempt to simulate the effects of a number of non-pregnant cycles on the endometrium, a group of bitches were subjected to a series of artificial cycles. Each cycle consisted of 10 daily injections of 5 mg. of stilboestrol dipropionate followed by 20 daily injections of 10 mg. of progesterone. Uteri were examined after 2, 4, 6, 8 and 10 cycles.

Half the animals were subjected to continuous treatment and the other half were allowed a period of 20 days without treatment between each cycle.

Though there was considerable glandular proliferation and increased secretory activity after 2 such cycles, cystic glandular hyperplasia of the endometrium was not well developed until the fourth cycle. These cystic changes were similar in every respect to those seen in the natural disease. Cystic glandular hyperplasia was present in uteri subjected to further cycles but the histological picture was modified by the fibromatogenic activity of the oestrogens and there was a progressive fibrosis of all uterine structures. Inflammatory changes were not present in any of these uteri and it seemed unlikely that further treatment of this type would lead to an endometritis.

At this stage in the experiments, 2 animals had undergone 5 cycles of this type, and in the sixth cycle the dosage level of progesterone was raised from 10 mg. per day to 50 mg. These animals remained healthy until the middle of the progesterone phase of the sixth cycle when both showed loss of appetite and occasional bouts of vomiting. There was a concomitant leucocytosis.

The uteri were swollen and contained quantities of muco-pus. *E. coli* was isolated from the uterine contents of one case.

Histologically there was a pronounced cystic glandular hyperplasia with a superimposed acute endometritis similar to that observed in the natural disease.

It seemed possible that the dosage level of progesterone used in all the previous experiments had been too low, and therefore animals were submitted to single cycles in which the progesterone dose was raised to 25 or 50 mg. per day. Even after 60 days' treatment with these dosage levels there was no evidence of inflammatory changes in the endometrium.

If, however, animals were submitted to cycles of 10 daily injections of 5 mg. of stilboestrol dipropionate followed by 20 daily injections of 25 mg. of progesterone, an acute endometritis developed in the progesterone phase of the fourth cycle. Occasionally, this inflammatory reaction became superimposed on the cystic endometrium in the third cycle and, less frequently, in the fifth cycle.

The uteri were grossly enlarged and contained considerable quantities of pus from which bacteria were isolated in the majority of cases. Histologically, the uteri exhibited all the changes observed in the acute forms of the natural disease.

An acute endometritis was induced in certain cases and the progesterone treatment was stopped. There was a profuse vulval discharge with dramatic relief of symptoms on the third or fourth day after the end of treatment. These animals were hysterectomised on the 15th day after the end of treatment, by which time they had completely recovered. The uteri had decreased in size but still contained a small amount of mucin. Histological examination showed cystic glandular hyperplasia with a diffuse plasma cell infiltrate similar to that observed in Group II of the natural disease.

Lesions similar to the chronic form of the disease can be produced by a combination of hormonal treatment and surgical interference with uterine drainage.

Discussion

These experiments indicate that cystic glandular hyperplasia of the endometrium can be produced in the bitch by prolonged administration of progesterone. There is no evidence to suggest that oestrogens play any significant part in this process, though they do enhance the effects of smaller doses of progesterone. Progesterone appears to determine not only the degree of cystic change, but also the initiation and extent of the subsequent inflammatory reaction which would not supervene until a certain threshold level of progesterone was exceeded. This is in keeping with the finding of corpora lutea in the ovaries of natural cases of endometritis. There is a further parallel with the natural disease in that both appear to require to undergo several cycles before inflammatory changes supervene. Withdrawal of progesterone treatment causes regression of the experimentally produced acute endometritis; similarly, ovariectomy results in regression of the natural disease. The plasma cell lesion found after withdrawal of progesterone treatment in the experimental disease is histologically similar to that observed in natural cases seen in association with regressing corpora lutea. This suggests that the pathogenetic sequence of changes in the cystic hyperplasia-pyometra complex may be similar to that observed in the experimental disease. There is, as yet, little experimental evidence to link the chronic lesions with those in the other groups, but it seems possible that they develop after a number of acute attacks as the history suggests.

Acknowledgments.—The author wishes to thank Dr. W. F. H. Jarrett for his advice and criticism, members of the clinical staff of the hospital for their help in obtaining clinical material, and Dr. W. J. Tindall of Organon Laboratories Ltd. for the supply of hormones used in the experimental work.

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THE SPEAKER'S INTRODUCTION

Mr. C. Dow, in introducing the paper, thanked the Organising Committee for the privilege of presenting this paper. He hoped to amplify and, if possible, clarify what he had written on the correlation of the clinical disease and the experimental results. The survey of the natural disease indicated that approximately 12½ per cent. of apparently normal bitches were affected by cystic hyperplasia of the endometrium. The incidence rose to 17 per cent. in animals over 5 years and the lesion was found at all stages of the oestrous cycle. The survey gave no indication of the duration of the disease. It would appear that absence of pregnancy was an important factor in the development of the lesion since 80 per cent. of affected animals were nulliparous.

An acute inflammatory reaction might become superimposed on cystic hyperplasia. The survey indicated that this occurred only in the luteal phase of the cycle and was more frequent in the first 40 days after oestrus. This would suggest that there was some relationship between the inflammatory reaction and progesterone activity. Without treatment it would appear that acute endometritis might either proceed to death of the animal or to spontaneous recovery. The endometrium during the recovery phase would appear to be of the type described in Group II of the survey, *i.e.* with a plasma cell reaction superimposed on the cystic hyperplasia. The significance of the plasma cell lesion was not clear. It might be a reparative process peculiar to the endometrium or it might be an immune phenomenon.

Chronic endometritis generally appeared at a later stage in the cycle than the more acute lesions and it was possible it might develop from cystic hyperplasia through acute endometritis all in the one cycle. It appeared more likely from the survey that it developed after a number of acute attacks over several cycles.

The survey indicated that the cystic hyperplasia-pyometra complex was in some way related to the functional activity of the ovaries. This was supported by the fact that the clinical disease could be cured by ovariectomy.

The theory that the cystic hyperplasia-pyometra complex was the result of hyperoestrinism had been current for over 20 years despite the lack of confirmatory evidence. Such evidence that did exist was largely comparative in that cystic hyperplasia could readily be produced in rodents by means of oestrogen treatment. In the bitch the aetiology appeared to be different since cystic hyperplasia could not be produced by oestrogens in the present experiments. Even after 400 days' treatment there was no evidence of any change resembling cystic hyperplasia.

Cystic glandular hyperplasia of a mild type could be produced by means of progesterone treatment for periods of up to 60 days. The degree of cystic change could be increased if the animals were subjected to a short, preliminary period of oestrogen treatment. Oestrogens, however, were not essential since the reaction could also be enhanced by increasing the progesterone dose. This suggests that progesterone and not oestrogens was the essential factor for the production of cystic hyperplasia in the bitch. Inflammatory changes were not observed in those animals subjected to single periods of progesterone treatment.

If animals were subjected to a number of artificial cycles of alternating periods of oestrogen and progesterone, cystic glandular hyperplasia developed after 4 cycles. If the progesterone level was low, the cystic lesions showed little tendency to progress with further treatment and the uterus became fibrosed due to the oestrogen activity. Inflammatory changes were not observed in any of the cases. If, however, the progesterone level were raised after cystic hyperplasia had been produced, then an acute inflammatory reaction occurred during the period of progesterone treatment. It required 4 cycles with the high level of progesterone to produce an acute endometritis. It would therefore appear that both cystic hyperplasia and a high level of circulating progesterone were essential for the development of an acute endometritis similar to that seen in the natural disease.

That this endometritis was progesterone dependent was further illustrated by the fact that spontaneous recovery occurred after stopping the progesterone treatment. The lesions seen in the experimental cases which were recovering from acute endometritis were similar to those seen in Group II of the natural disease, *i.e.* they showed a plasma-cell reaction superimposed on cystic hyperplasia.

It was possible to produce lesions resembling the chronic form of pyometra by ligating a uterine horn and allowing the animal to recover from an acute endometritis. This suggested that in some cases chronic endometritis could be produced by failure to discharge uterine fluid after an acute endometritis. It therefore seemed possible that the pathogenetic sequence of events suggested by the survey of the natural disease did in fact occur.

The Opener

Mr. R. H. Clover said he considered it to be a very considerable honour to be asked to open the discussion. Of 120 cases that he had seen over the last 8 years, 85 (or 75 per cent). were over 7 years old. Sixty of those, or 70 per cent., were nulliparous; the remainder uni- or multi-parous. Of the remaining 35, 2 were between 2 and 3 years, and 33 were between 4 and 7 years.

The significance of those observations lay in the fact that the majority of the cases seen in practice were elderly maiden bitches. That, of course, fitted in with the observations of all research workers and practising veterinary surgeons, and was therefore common knowledge. The feature of this complex that might not be fully understood was that it is, in the main, of a non-infective nature. As Mr. Dow and other workers had shown, no specific organism had been isolated. Many bacteria had been found, but none was proved to be responsible for the complex in its own right; in other words, they were secondary to the condition. Those facts left them with the conclusion that the condition was more likely to be one of hormonal imbalance.

The one feature that disturbed him was that the incidence was highest in elderly maiden bitches. If one casts one's mind over the range of domestic animals that incurred the complex, it was the bitch that suffered from it most, and mainly in a non-specific or spontaneous way. Other animals incurred the complex, but usually from a specific cause of an infective nature after parturition. He had never seen a case occurring spontaneously in a cat or any other domestic animal that led a natural life. Those observations led him to suspect a psychological cause. Of all creatures, the bitch led the most unnatural life. She came in season, on average, once every 6 months, and 99 times out of 100 the poor creature was sent into "purdah" time and time again, and she must become very frustrated as the years went by. Mr. Dow was inclined to support that contention in his present discourse. He had not mentioned it in his first report of December 14th, 1957, in THE VETERINARY RECORD, so apparently they had come to the same conclusion by different routes.

The stress occasioned by the repeated suppression of natural instincts puts a severe strain on all the endocrine glands and upsets the balance. But of all the glands concerned, the one that became most affected was probably the pituitary, in so far as it played a major part in the control of the sexual cycle. It was the pituitary that initiated the onset of oestrus, by the production of the follicle stimulating hormone from the anterior lobe. It was the pituitary that initiated the formation of the corpora lutea by producing the luteinising hormone also from the anterior lobe. It was the pituitary that caused the termination of pregnancy by the production of oxytocin from the posterior lobe.

This might not be the complete story, because if the initiation and maintenance of pregnancy was under hormonal control by the anterior pituitary, what substance caused the corpora lutea to regress after normal season, and what substance determined their function at the end of pregnancy? Oxytocin acted, so it was said, by direct action on the musculature of the uterus, thereby bringing about a mechanical contraction and parturition. It was known, of course, that that was not the only action that it had, but he could not find any reference that it had any action on the ovaries. But surely something must have, to cause the cessation of the production of progesterone; otherwise it was likely that the gestation period would be prolonged indefinitely? Probably something like that did actually happen in pyometritis.

Mr. Clover based that theory on one outstanding feature which was concerned with the diagnosis of pyometra. That syndrome was well known—the commonest form occurring 7 to 9 weeks after a heat period. The bitch concerned suddenly went off her food and started drinking copious quantities of water; not just fluids in general, but always water. She also passed floods of urine of a low specific gravity. That, taken in conjunction with a swelling abdomen, was often sufficient to diagnose pyometra. The sudden desire to drink water had puzzled him in the past because it was not of bacterial origin and there was seldom any fever. Then he realised that one outstanding disease could be compared with it: diabetes insipidus. That complaint also produced inappetence, thirst, and polyurea of a low specific gravity, and it was caused by a disturbance of the pituitary gland, and of the posterior lobe in particular. It could be proved that it was the posterior lobe that was affected in diabetes insipidus by the action of posterior pituitary extract, which in cases of this disease would materially reduce the quantity of water consumed for several hours.

Because of that it seemed a logical assumption that it was indeed a disturbance of the posterior pituitary that caused thirst in pyometra; and it was from that part of the gland that oxytocin plus an unknown factor was produced to terminate heat, false pregnancy, and pregnancy.

Pyometra could be cured either by ovariotomy or panhysterectomy and thirst subsided, so there could be no permanent damage to the posterior lobe, or diabetes insipidus would be the inevitable result. Why that was not so was perhaps because once the abnormal calls by the ovaries upon the posterior pituitary no longer existed, it returned to its normal anti-diuretic function; in other words, remove the inhibitory effect of the ovarian hormones upon the posterior pituitary and a cure was obtained.

The foregoing was pure theory, and Mr. Dow's opinion as to whether there could be any basis in fact for it would be appreciated. He had consulted several members of the medical profession about this theory and they all agreed that they could not at the moment offer a better explanation; except perhaps that the corpus luteum could be regarded as a flower that grew and reached maturity and died a natural death. But as all the other functions were under hormonal control, they agreed that it was quite possible that the corpora lutea were as well, although it was not known for certain if that were so.

Diagnosis presented little difficulty in most cases as there were certain cardinal signs. The bitch suddenly became ill 7 to 9 weeks after a season. Water was consumed in ever-increasing quantities. The abdomen enlarged in size or a thick creamy or sero-haemmorhagic discharge appeared. Emesis was often a feature in the later stages. The temperature was seldom elevated. Diabetes insipidus showed increased thirst, inappetence without enlarged abdomen, no discharge or emesis.

Splenic tumour most closely resembled pyometra clinically. There was increased thirst, inappetence, emesis, and swelling of the abdomen. He had seen 3 cases which, upon laparotomy, proved to be splenic tumour. He could offer no satisfactory explanation as to why thirst was increased and appetite decreased, unless it was a matter of mechanical pressure on the stomach giving a feeling of fullness and, by pressure, causing emesis.

Of all the treatments advocated, surgery was the most successful in removing the cause. It was the one of choice for 3 reasons: (1) the incidence was mainly in elderly maiden bitches and they were not likely to be called upon suddenly to produce a litter; (2) there was no guarantee that if medical treatment proved successful it would not lead to a recurrence of the condition; (3) medical treatment had proved singularly disappointing, at any rate in the speaker's hands.

If the assumption was correct that the posterior pituitary was being overtaxed, then it would seem at first glance that posterior pituitary extract alone, or in conjunction with some other drug that caused relaxation of the cervix and led to drainage of the uterus, would be successful every time. That, unfortunately, was not the case, as the inhibitive

action of the persistent corpora lutea on the pituitary was so strong that the extract was itself inhibited as well. This could easily be so, because in cases of parturition the extract worked by causing contractions of the musculature of the uterus; but in pyometra it appeared to have little action unless given in large doses over a protracted period, and then not always.

The use of what might be called anti-hormones, notably testosterone, would appear to be a line of treatment that should meet with success. After all, stilboestrol would, in a number of cases, effect reduction of prostatic tumour, and feminisation of male dogs could be corrected by testosterone. Testosterone implants were used with great success in some cases and in others with very disappointing results.

Chorionic gonadotrophin had been tried with varying success. The use of this substance seemed less logical than testosterone, as it introduced further hormones of the female range that were follicle stimulating and luteinising. When the hormones worked, it was because they gave that little extra kick to whatever substance was produced by the posterior pituitary that caused the termination of pregnancy, heat, and false pregnancy.

The treatment recommended by Cowie and Muir, using quinine sulphate, did help, but in his own hands it had not been entirely successful. Their theory of its action was sound, and quinine sulphate was the one substance that could bring about relaxation of the cervix and convert a closed into an open case; then posterior pituitary extract in adequate dosage would do the rest.

The treatment that appeared to be the most consistently successful one, and for which there seemed to be no satisfactory explanation, lay in the use of the antihistamine drugs. Presumably it was because of their anti-inflammatory action. What was Mr. Dow's opinion as to the action of those drugs upon the endometrium and/or ovaries? It appeared to be a complex that might respond to the corticosteroids, not only for their hormone-stimulating properties, but also because of their remarkable anti-inflammatory action. He was working on that line at present and hoped to have some definite results soon.

However, in the light of present knowledge, surgery was still the procedure of choice.

The General Discussion

Mr. J. A. Dall (Torquay): "I should like to thank Mr. Dow for the presentation of a factual paper which goes a long way to explain scientifically a common clinical syndrome.

"To my mind the most valuable contribution, which was passed over by Mr. Dow rather quickly, was the reference to the production of a similar condition in pets with the use of oestrogens whereas it would appear from the paper that progesterone is the primary factor. It brings it home how easily we can be led into the trap of assuming that the drug effect on any organ is the same for all species.

"Mr. Clover's theory cannot be commented upon at this stage, but I am sure it is worthy of detailed study when the paper is published.

"I have noticed that frequently the complex follows pseudo-pregnancy and also that for a considerable time before clinical symptoms develop there is an enlargement of the mammae and a persistent secretion of milk.

"Does Mr. Dow consider that the uterus requires to be sensitised by oestrogen before pituitary can act on it?"

Dr. E. Cotchin (London): "There is a need to continue the investigation of the 'breeding history' of bitches with pyometra which, in many respects, is similar to that of bitches with mammary tumours. Is there a general endocrine upset in bitches which do not breed regularly which may manifest itself in different ways? Mr. Dow has used young bitches in his experiments. Can pyometra be produced experimentally in older bitches that have previously bred normally? Can the symptoms be relieved by taking the uterus out, and leaving the ovaries in?

"Plasma cells can be found in other chronic conditions in dogs, *e.g.* cystitis. It is important to remember that the mechanism of production of disease of endocrine origin may differ in the natural and the experimental condition."

Miss J. O. Joshua (Finchley): "I should like to refer to occasional cases of pyometra in barren entire female cats which resemble pseudo-pregnancy and which could be correlated with Dow's progesterone theory.

"Pyometra is now occurring in younger and breeding bitches and the symptoms are not always typical. It is frequent in bitches showing marked pseudo-pregnancies. These pseudo-pregnancies are of two types: (1) those showing sluggishness and abdominal distension, and (2) those in which lactation is present. Pyometra is more frequent in the former type.

"Residual ovarian tissue does not affect clinical recovery, but results with quinine are disappointing and irregular."

The Reply

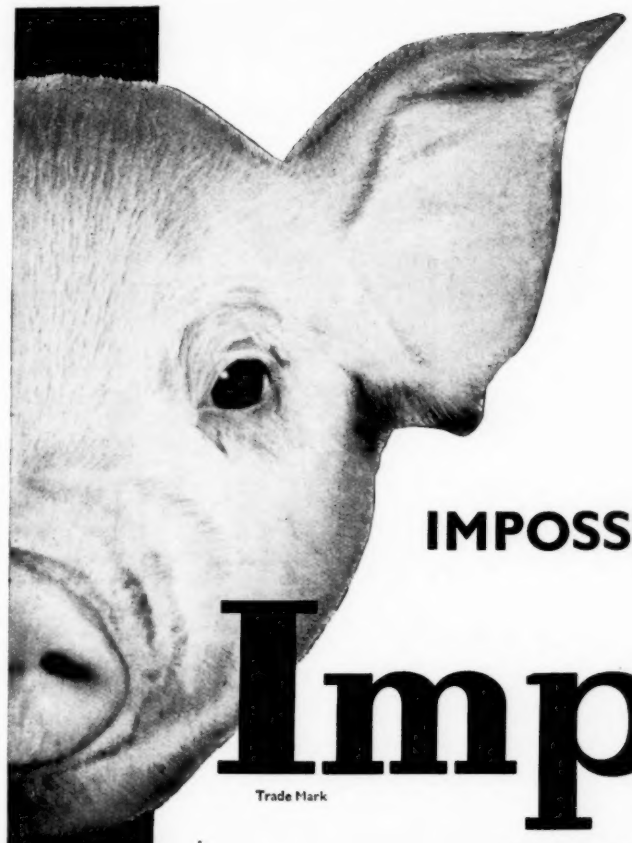
Mr. Dow, in reply, noted that the opener had formed the opinion that the cystic hyperplasia-pyometra complex was associated with a departure from the natural breeding life of the bitch. Benesch and Pommer (1930) had observed this and had suggested that pyometra should be classified as a disease of domestication because of its high incidence in household pets prevented from breeding naturally. The basic cause of the disease would appear to be absence of pregnancy since the disease is never seen in animals breeding at frequent intervals. Similar degenerative lesions of the endometrium have been observed in heifers prevented from breeding for a number of years.

Little was known of the part played by the pituitary in the pathogenesis of the disease though it was possible that the ovary acted only as the mediator of pituitary dysfunction. There was little evidence that the posterior lobe of the pituitary had any direct effect on the ovary though its action on the uterus was well known. The lack of knowledge of pituitary-ovarian relationship was clearly indicated by the large number of hormones used in the treatment of pyometra. Hormonal treatment had been largely empirical but there was some justification for the use of testosterone since it was known to cause ovarian atrophy. Preliminary studies suggest that the atrophic action of testosterone may be too slow to have any great value in the treatment of acute endometritis. Theoretically, posterior pituitary extract should have a useful ecbolic effect on the uterus even in the absence of oestrogenic sensitisation but it was doubtful if the myometrium would be fit to respond in many cases.

Mr. Dow was aware of reports of the use of quinine in the treatment of pyometra in the bitch but had no personal experience of its use. He knew that it had an ecbolic effect but suggested it might also have a direct effect on ovarian function since there were reports of oestral abnormalities in women receiving quinine. He doubted if it would prove to be the panacea of genital diseases as suggested by the original reports. He had no personal knowledge of the use of corticoids in the treatment of pyometra but suggested that the known properties of these compounds did not indicate that they would be of value. It appeared that until a compound which would produce rapid atrophy of the ovary was found surgery would remain the treatment of choice in most cases.

Mr. Dow agreed with Miss Joshua that pyometra was not uncommon in the barren cat and suggested that the aetiology might be similar to that shown in the dog. Like Miss Joshua, he had recently observed a few cases of pyometra in bitches which had bred irregularly and had noted that in these the disease was usually of a low-grade type. He had attempted to discover the relationship between pyometra and phantom pregnancy but had met with scant success because of the lack of material from cases of phantom pregnancy.

He agreed with Mr. Pittaway that there was some evidence of an increase in the incidence of pyometra following the use of stilboestrol in mesalliance. German workers had observed this and had suggested that the use of stilboestrol in these cases produced the equivalent of an additional cycle.



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PAC 1958/4

Livestock Improvement in Britain

BY

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I SHALL be dealing with livestock improvement in the narrow sense, that is, in relation to the improvement of genetic quality. At the same time, however, it must be realised that livestock improvement is based too on the improvement of an animal's environment so that it may give a fuller expression of its genetic potential. In this connection a tribute must be paid to your profession for developing effective controls of such diseases as pulpy kidney, contagious abortion, piglet anaemia and now nematodiriasis. The debt of the animal husbandman will indeed be a substantial one when you have laid by the heels hypomagnesaemia, Johne's disease, scrapie and, for good measure, the leucosis complex in poultry. The same progress cannot be reported from the genetic improvement front, but nevertheless the situation now is a most heartening one because during the past 5 years there have been several key developments which have introduced an objectivity into animal breeding which, hitherto, has been lacking.

These developments are not all the result of new knowledge. For example, in establishing a chain of 5 pig progeny testing stations, we have done no more than set up an organisation the Danes have had for nearly half a century. It is true that there are considerable advances in the techniques of progeny testing which are being used in these new testing stations, but basically this approach to selection is a long-established one.

The important feature is the change of heart that has brought about this development. In common with breeders of other pedigree livestock, pig breeders have relied on the individual excellence of animals, judged purely on their phenotype, though some attention was paid to family nomenclature as a result of an ingenuous belief that in females there was a transmission of virtues down the female line and in males a corresponding but equally misplaced faith in transmission from sire to son. When one presented a pig for sale, apart from the names in the pedigree, there was little information apart from date of birth and the numbers born and reared in the litter to which the pig belonged. Vital information as to food conversion rates and carcase quality of sibs and half-sibs was entirely lacking and there was no real pressure from the commercial side of the industry to provide such information. As the progeny test stations get under way and their results are disseminated this situation will change rapidly. Such is the pressure on pig production in this country commercial producers will only keep in business if their pigs grade sufficiently well to earn premium prices and there is a good conversion of feeding stuffs. Both of these traits are strongly influenced by a pig's genotype.

One cannot, however, expect spectacular results from progeny testing. There is not a nucleus of pigs in this country comparable with the best of the Danish pigs, which merely require multiplication to bring us to parity with the Danes. The nature of the improvement problems is such that even with the optimum use of the data available in formulating selection programmes, only small cumulative gains can be made as generation follows generation. This is, however, preferable to the situation where we were standing still.

Changes in the appraisal of stock have probably gone further in dairying than in any other branch of livestock production. Here a leading part has been played by the Production Division of the Milk Marketing Board through the responsibility it carries in administering the major part of the artificial insemination services. Approximately one-half of the dairy cows of Britain are artificially mated and so a great responsibility rests on those who are responsible for choosing bulls. In the first instance bulls were chosen on the milk records of their dams and half-sisters and on their appearance. In this last connection they had to satisfy the eagle eyes of livestock officers of the Ministry of Agriculture, who apparently were considered to be endowed with second sight. A considerable proportion of the bulls came from the fashionable herds, but because of price considerations they did not represent the cream offerings of such herds. On paper they looked to be above average for their breeds, but then the feeding and management in such herds was also above average. There was a difficulty in equating records to the expectations under more normal farming conditions. This difficulty has largely been resolved by the work of Dr. Alan Robertson of Edinburgh University, who is now regarded as one of the world's leading population geneticists. He developed the concept of contemporary comparison whereby a bull if he has daughters in many herds and mates by other bulls in the same herds is given a breeding value which is related to breed average.

When the first assessment was made of sires that had been used in artificial insemination centres it was revealed that they conformed very closely to their respective breed averages. The hope that artificial insemination would be a potent force in raising the genetic merit of the national herd was not being realised because of inaccurate selection of sires. Since then there have been considerable changes in bull selection policies. One of the most interesting of these is by means of nominated services. The Board's staff has built up a list of outstanding pedigree cows in respect of longevity, wearing qualities and consistently high production. These, by arrangement, are mated to the best avail-

able sires judged on the comparative production and the type of their daughters. There is now a steady flow of promising young bulls coming in to A.I. stations. These are, in the first instance, used only to provide a sample of daughters so that they can be appraised before a decision is made to use them widely. In this connection there have been hopes that the deep freezing of semen would provide a means of building up banks of semen during a bull's resting phase. If the bull has no particular merit then the semen can be destroyed, but if he is a good one, then he can be exploited fully. It appears that the snags in applying such a technique have not yet been sufficiently ironed out to make such an arrangement a practical proposition. Certainly it has been my experience on our College farms that insemination with "cold" semen is not sufficiently reliable to give a satisfactory conception rate. Whatever virtues a system of artificial mating may have it is not a practical proposition unless it matches natural mating in getting cows in calf. A farmer cannot afford to be interested in the genetic worth of future generations if the immediate generation with which he is working is not in full production because of long calving intervals.

The development of artificial insemination to its present level and the new systems of sire appraisal are altering radically the character of pedigree dairy cattle breeding in this country. In the first place there can be a much greater intensity of bull selection for only half the bulls are required now as compared with 15 years ago. Secondly, the initiative in breed improvement, so far as the major dairy breeds are concerned, has moved from the breed societies to the authorities controlling artificial insemination. The old labels of excellence such as Registers of Merit, set up by the breed societies, are losing much of their significance in favour of evaluation of levels by contemporary comparison. This is no loss, where Registers of Merit are highly selective and consider only the best of a bull's offspring and discard his poorer get.

The individual breeder, working on traditional lines, is also losing ground. Because of the limited number of animals at his disposal he cannot generally embark on a programme of progeny testing and still have sufficient matings available to exploit a good sire if one comes along. Such are our imperfections in predicting the breeding worth of a young sire, there is a very great element of luck in the success of the individual breeder. The Milk Marketing Board, on the other hand, has the resources to test a large number of sires simultaneously, and so is able to build up a nucleus of quality sires of proven ability. These are available at quite moderate fees to the private breeder who is now in a position to base his mating programme on the use of proven sires. At the present time some 25 per cent. of all pedigree registrations result from artificial matings and the likelihood is that bulls with a high contemporary rating will become increasingly important.

So far only one breed society has reacted to this development and this is the Jersey Society, which has recently announced an arrangement whereby a bull of its own choice is now standing at the Cambridge Cattle Breeding Station for use by its members. This potentially is all to the good, for monopolies are usually dangerous and particularly is this so in animal breeding, for deficiences in our knowledge could easily lead to catastrophe as a result of over-concentration on blood lines which carried an undesirable recessive. We have the warning of the condition known as congenital lameness which became very widespread in the Red Dane breed as a result of using very widely a bull and several of his sons who were carriers of the defect.

On the other hand, mobilisation of performance data and their use in a national breeding plan along the lines followed by the Milk Marketing Board is highly desirable, provided wise decisions are taken. In a sense the position in dairy cattle breeding is becoming more akin to that in plant breeding, where decisions on selection and mating plans are made by specialists who have the resources to make a full appraisal of the material with which they are working. We cannot hope for spectacular gains as a result of simple genetic situations for it is very seldom that important economic traits have a simple genetic basis. Most of the traits with which the farmer is concerned have a complex polygenic basis and are strongly influenced by environment. We have, therefore, to rely on the application of knowledge from the new science of population genetics, which in turn demands large numbers before there are sufficient data from which valid conclusions may be drawn.

There is evidence, too, of a concentration of breeding decisions in the hands of a relatively small number of people in another branch of livestock production, namely poultry. It looks as though in a matter of a few years the supply of day-old chicks will be a virtual monopoly of a few big combines, who have the resources to carry out the exhaustive testing which is necessary to produce satisfactory hybrid lines. This development arises from the spectacular success obtained in the United States from hybrid maize. The technique was applied there to pigs and poultry and has now arrived in this country. There is no question but that the best of these hybrid lines are exceptionally good producers but it has not been satisfactorily established that equally good results could not have been obtained by family selection within breeds and by first crosses of breeds where effective family selection had taken place. Lerner's work in California and work which I initiated at Wye College which has been carried on by E. A. Maddison, suggest that we are still very far from reaching a genetic ceiling within our pure breeds simply because the methods of selection are inadequate. In an appraisal of the two systems of breeding it is important to remember that the apparent superiority of hybridisation may be due not to the method so much as to the intensive selection that is being practised. In other words, if the same resources were applied to within breed improvement as are being applied to hybridisation we may have equally good results.

As in the pig industry, there has recently been an establishment of testing stations and once again we have evidence of the concerted national effort towards livestock improvement which, as has already

been pointed out, is such an encouraging feature of our present situation.

Unfortunately we cannot claim the same sort of progress in the less intensively kept livestock. The breeding of sheep and beef cattle is still very much in the same position as it was 50 years ago, where main reliance is placed on the skill and intuition of the individual breeder. Population genetics has made a comparatively small impact on this side, largely because of a paucity of definite measurements to define production. There is nothing comparable to milk or egg yields for the breeder or population geneticist to get his teeth into. However, there are changes in progress here, again as a result of American experimental work, especially that at the Montana Range Experiment Station with Herefords. There, and elsewhere in the United States, it has been established that the characteristic weight-for-age is strongly inherited. In other words, under standard rearing conditions, there is a high correlation of performance between close relatives. This means that if one selects a sire because of his superior weight-for-age from weaning to 15 months the expectation is that his offspring will be above average. This in a large measure obviates the expense of progeny testing as well as the long generation interval that is involved, without any sacrifice in rate of genetic improvement for a most important economic character. Above all it is the weight of beef that a farmer sells in a given time which determines the profitability of his enterprise. Furthermore, other American work has shown that there is a high correlation between weight-for-age and efficiency of food use, another important economic consideration.

These developments have led to the concept known as "Performance Testing." Weaner bulls are recorded under standard conditions over a standard period and preliminary culling is made on this basis. The records, however, give no indication of transmission of weakly inherited characters such as carcase quality, and if this knowledge is required then resort to progeny testing is unavoidable. Performance testing does, however, narrow this field for the more expensive progeny test.

The reaction of farmers to performance testing in the United States has been an immediate one. There is already a strong demand for performance-tested bulls and substantial premiums are being paid for bulls with high ratings. These are not of the compact type which we regard in Britain as the "export" type but are bigger-framed bulls which the pedigree breeder normally regards as crossing types. It is likely that there will be a considerable change of fashion, not only in the United States but in the British Dominions and the Argentine as well. New Zealand has already made a start on performance testing and in that country farmers are very quick on the uptake. We shall probably see the impact of this on export demand. Leading overseas breeders are not likely to come to us for stock as they have in the past if we cannot provide them with the material they want, which apparently is not the compacted type, which in the United States is associated with dwarfism.

However, a start has been made on performance testing in this country. Last autumn 10 Hereford bull calves from well-known herds were assembled at the Rosemaund Experimental Farm in Hereford and are now being reared and recorded under standard conditions. Eventually most of these bulls will end up in artificial insemination stations and the intention is to carry the test to its logical conclusion by testing their performance as sires of cross-bred calves from the dairy industry.

The Rosemaund development was followed by similar studies with Aberdeen Angus and Shorthorns by B.O.C.M. Ltd., at Bareby in Yorkshire. There is a suspicion, if not a general realisation, that worship of the Perth ideal may not be in breeders' best interests.

Strangely, but perhaps not surprisingly in this country of contradictions, the most advanced work on the appraisal of beef transmitting qualities is being carried out with a dairy breed—the Friesian. Currently some 30 sires are under test and in this work Cockle Park, the research station for which I am responsible, is co-operating with Dr. Ian Mason of Edinburgh. There are two main aims in this work. The first is to determine the extent of genetic variation in respect of fleshing qualities within the breed and the second is to establish whether there is any incompatibility between fleshing and dairy qualities. The sires being tested are all standing at A.I. stations and though the steers are collected for rearing under as near standard conditions as possible the daughters of bulls will be recorded in the normal course of events on farms and their sires will be assessed by contemporary comparison.

It is most important that we establish the feasibility of selecting for better beef qualities without detriment to dairy ability, because otherwise we may place the Friesian breed in jeopardy. It has become the most important breed in Britain, almost entirely at the expense of the Dairy Shorthorn. This latter breed fell from grace largely on the score of milk yields because it is milk and not meat on which the viability of the typically small stock farms of Britain depends. Unfortunately for the Shorthorn breed there was no satisfactory measurement of dual purpose function and no real definition of objectives. The study referred to may provide information which will safeguard the position of the Friesian, which, fortunately for us, is proving to be a most useful beef breed. The problem is one of knowing how far to go in this direction.

When we turn to sheep breeding the situation shows less change than that in any other species of farm animal. There is very little research in sheep breeding in progress in this country though Dr. Donald of the Animal Breeding Research Organisation has some admirable fundamental work under way. It is on the applied side that there is so little being done. There are only two university departments studying the inheritance of economic traits, namely King's College, Newcastle upon Tyne and the University College of North Wales at Bangor, and both of these projects are on a small scale. The result is that the pedigree breeder continues to select for the accepted standards of his society, but we have no assurance that these standards represent the optimum so far as economic worth is concerned.

As in beef cattle the great handicap is a lack of precise measurements and some form of organised recording is a prerequisite in order to define the genetic situations. The position, of course, is complicated by the wide environmental range over which the breeds must perform and the differing emphases that result from this breadth of function. However, a start has been made on a plan to provide a sheep recording service in Britain. Currently a committee set up by the Farmer and Stockbreeder and the National Sheep Breeders' Association is working out a scheme which will come into operation in 1959.

Immediately there is one great service that the geneticist could do for the sheep industry in Britain and that is evolve a breed such as the South African Dorper, which will take the ram while suckling and so give two crops of lambs in the year. It would result in a very great improvement in the efficiency of fat lamb production.

Here we are looking well into the future. But we have to do that fairly consistently in animal breeding, for progress is slow as a consequence of low reproductive rates, long generation intervals and a multiplicity of objectives in most species. It will be future generations who will judge our present efforts rather than our own generation.

Diseases of the External Auditory Meatus of the Dog and Cat

BY
JOAN O. JOSHUA
Finchley

Introduction

IT would appear that a paper on a subject as common, as widespread and as well recognised as diseases of the external auditory canal of the dog and cat should be simple to produce. Brief consideration of the material available soon suggests that this assumption is unwarranted and that there is, in fact, a great dearth of fundamental knowledge on the whole matter.

A survey of some of the more recent literature immediately reveals the fact that authors have largely confined themselves to a few narrow aspects of external ear disease, such as bacteriology, classification and treatment, both the latter treated in a purely individual style, therapy in particular often referring to the use of only one agent in a given series of cases. Fundamental matters such as normal and pathological histology have but rarely been discussed and it becomes obvious that there are enormous gaps in the knowledge which every veterinarian should be able to take for granted as fully established when thinking about ear disease.

If this paper succeeds only in drawing attention to the deplorable absence of fundamental data concerning the external auditory meatus of the dog and cat it will have been well justified.

THE DOG

Review of the Literature

A brief and necessarily incomplete review of the literature of the last 10 years has been attempted.

As mentioned above, much of this work has been confined to a narrow aspect of external ear disease, and articles which have purported to describe the use of a single therapeutic agent or some similarly restricted field have been largely ignored.

Many bacteriological surveys and some experimental studies have been made, most of which are in fairly general broad agreement.

The only really broad-based study appears to be that by Witter in 1949, in which the author not only attempts classification of types of otitis in the dog and deals with treatment, but also, and most important, discusses normal and pathological histology as he has found it. The main point of interest regarding histology is that Witter believes the only type of gland found in the normal integument of the meatus is the sebaceous gland, found always in association with hair follicles. He contends that ceruminous glands appear only in the abnormal integument. It may be justifiable to question the validity of these two statements, but in the absence of definite information his conclusions cannot be refuted. This point will be referred to again under the heading of the normal integument. Witter classifies external ear disease as acute, chronic, ulcerative, suppurative, indurative, ceruminous and miscellaneous.

Points of interest regarding treatment are his preference for stimulating dressings such as resorcin, oil of cade, silver nitrate and salicylic acid to promote healing when hypertrophy has occurred, and his confidence (often misplaced in the author's opinion) that ulcers in ears "yield promptly" to cauterisation with silver nitrate.

Zepp in 1950, discussing ear diseases of the dog and cat, stresses the importance of using bland agents for cleansing, his preference being for soap and water. He places great emphasis on two factors in ear disease, *viz.*, ear mites and perforated drums. He claims that the latter type is cured by surgery. He also describes his own modifications of the operation of aural resection.

Kaufmann and Frost (1949) draw attention to the role of ear mites, *Otodectes cynotis*, in external ear disease of the dog, having found these parasites in 56 per cent. of a series of 50 cases.

Dam, in 1952, investigating the bacterial flora in cases of external otitis in dogs found that 16 of 17 cases yielded staphylococci, and that in one case Pseudomonas was also present.

McBride in 1954, discusses certain predisposing factors in cases of persistent otorrhoea and refers to the type of ear and the character of the meatus, drawing attention to the part played by narrow and hairy canals, points which the author believes to be of very real importance and which will be discussed later.

McBride found that infections due to Pseudomonas and *Escherichia coli* were resistant to treatment.

Hopkins, in 1955, discusses the use of hydrocortisone with and without neomycin; his results were disappointing, less than 50 per cent. being cured and with no improvement in cases of chronic thickening.

Gustafson (1955) in an exhaustive study of clinical and experimental cases deals mainly with the bacteriological aspects, his findings according largely with other bacteriological studies which will be discussed later.

The Normal Integument

To say that recognition of the normal tissue is necessary for the management of disease may seem almost insultingly to state the obvious, yet when the number of ear cases is considered in which conditions far from normal are left at the conclusion of

"successful" treatment it may be agreed that some description of the normal lining of the dog's external ear canal is warranted.

Macroscopic

The ear canal is lined by tissue which is a modification of the skin covering. It is a thin layer of tissue closely apposed to and following the convolutions of the conchal cartilage. Colour may vary from a pale pink to parchment; texture is smooth and fine and the appearance is that of lightly glazed or waxed paper; a few fine blood vessels may be seen coursing below the epithelium. The thickness of the epidermal layer varies somewhat between breeds, being thickest in the coarse-skinned breeds such as the Cocker Spaniel and thinnest in the thin-skinned smooth-coated breeds such as the Whippet. The integument should have only a sparse number of hairs; this is a vitally important factor in the causation of disease since in many breeds, particularly wire-coated types of Terrier and the soft-coated breeds such as the Poodle and Bedlington (which never shed the hair seasonally), a large proportion of individuals produce an abundant hair growth in the ear canal with the result that it has now come to be regarded as virtually normal. It is contended that this concept is wrong and that the ideal of an integument almost devoid of hair must remain fixed as a desired genetic objective, to minimise the incidence of external ear disease.

Histological

Here is met one of the great gaps in fundamental knowledge and one which requires attention from a number of workers.

It appears that the description of the histology of the human external auditory meatus has been accepted unquestioningly (except by Witter) in veterinary circles in so far as the matter has been considered at all. Thus it is merely regarded as a prolongation of the skin having the usual component layers; hair and sebaceous glands are found as also are ceruminous glands. This latter is contested by Witter who has found ceruminous glands only in diseased canine ears. This seems a difficult proposition to accept since small quantities of ceruminous material are found in very many apparently normal ears from a very early age.

Furthermore, whilst it can be accepted that pathological changes may easily result in hyperplasia and even increase in the number of glandular elements in a tissue, it is not easy to accept a contention that disease, usually of an inflammatory nature, can cause the appearance of a new type of gland which, one is asked to believe, was hitherto alien to that tissue. Hence, for the purposes of this paper and until such time as the hypothesis may be disproved by active investigation, the presence of ceruminous glands in the external auditory meatus of the dog will be regarded as normal.

Factors Predisposing to Disease

Many factors may predispose the canine auditory canal to disease and it has long been recognised that there is some breed incidence; this must vary with localities and differences in local breed popularities and with fashions and thus breed numbers. Whereas 5 to 7 years ago the Cocker Spaniel might have been regarded as the commonest ear patient, he has now probably given place in most areas to the Miniature Poodle.

Anatomy

The anatomical features of the canine external ear canal, *viz.*, the funnel-shaped conchal portion descending nearly directly vertically to meet the annular cartilage, at which point the canal takes an almost right-angled turn to continue medially in a horizontal plane and terminating at the tympanum, are so well-known as to merit no more detailed mention in a paper of this type. The terms vertical canal and horizontal canal are used subsequently in certain descriptions of signs and symptoms.

(a) *Conformation of the external ear*

Most clinicians recognise some increased susceptibility to ear disease in those breeds with long, drooping, heavily feathered ears such as the various Spaniel varieties. This has been believed due to inadequate ventilation, consequent incomplete evaporation and distribution of normal waxy and sebaceous secretions, and thus accumulation of waste products within the ear canal.

Dogs with erect or semi-erect ears are certainly less prone to conditions of the seborrhoeic type.

(b) *Conformation of the meatus itself*

Observation suggests that the type of ear canal least prone to disease is that in which the whole funnel-shaped portion is roomy, tapering gradually from a wide superior portion to a narrower neck at the junction of conchal and annular cartilages. The more roomy the funnel the more gradual and gentle are the rugae or convolutions into which the superior part of the concha is thrown thus providing less tortuous crevices into which normal debris may be deposited to act as possible sources of irritation and sites of infection. In addition the calibre of the horizontal canal is adequate.

The worst form of meatus is the small, narrow type with tight folds of cartilage, which descends almost as a narrow cylinder to the annular cartilage with little tendency to form a wide funnel-shaped opening superficially and with a correspondingly small-calibre horizontal canal. In such ears, cerumen, sebum and exfoliated epithelium are liable to become trapped between the tight folds of the rugae, thus effectively preventing normal metabolic tissue processes to continue, and providing a fruitful medium for bacterial multiplication as well as mechanical contact, inflammatory and hypertrophic changes and ulceration.

It is often possible, on examining a young dog, to hazard a pretty accurate forecast as to its probable susceptibility to disease of the external ear canal throughout life by an observation of the type and shape of its canal. Not only is there wide variation

between the types of conformation described above in different breeds but also between individuals within a breed.

(c) *Coat type*

Thin-skinned, smooth-coated dogs such as the Whippet have usually ears of good conformation, a wide flexible meatus lined by a thin epidermis of good quality bearing few hairs; this is also true of similar silky-coated breeds such as the Saluki, and ears of this type are not usually disease-prone.

Wire-haired breeds such as the Wire Fox Terrier, Airedale, Scottish Terrier and some Sealyhams, have as a rule ears of narrower calibre, lined with coarser skin which bears more numerous hairs, sometimes quite a profuse growth. These types are prone to ear disease, often of a chronic inflammatory type resulting in considerable hypertrophy of the integument.

Finally the soft-coated breeds, especially the Poodle and Bedlington Terriers and again some Sealyhams (the Kerry Blue seems rather an exception in this group) which have ears of varying calibre, usually lined with a thin fine quality integument but which, in a high proportion of individuals, is nearly as profusely covered by hair as the skin of the body surface. This type is prone to ear disease from a very early age owing to the great increase in glandular activity, with the resulting excessive secretions trapped by the mass of hair and forming concretions which rapidly act as mechanically irritating foreign bodies.

Naturally, all gradations of these types exist both within and between the groups described.

(d) *Skin type*

Thick-skinned breeds (*e.g.* Cocker Spaniel) appear to have a thicker and more glandular integument to the meatus and the abnormalities noted for the skin, *e.g.* seborrhoea, are repeated in the ear, thus again predisposing to secondary infection.

Breeds which show excessive cerumen secretion in certain areas of the body such as axillae, thighs and under tail (*e.g.* Alsatian, Bedlington, Dachshund) are likely to show similar excessive cerumen production in the ear, this itself being a clinical entity in external ear disease. Breeds having a fairly thick, dry type of skin prone to somewhat heavy exfoliation such as the Wire Fox Terrier may again repeat this epidermal pattern in the ear.

Virtually, then, the skin of the ear canal must be considered in every sense as a part of the normal (or abnormal) skin covering of that individual and any pathological deviations dealt with accordingly.

(e) *Breed incidence*

Clinical records and numbers of ear cases have not been kept separately, hence no statistical analysis is offered. It is probably more important to consider coat and skin types than individual breeds, but it is suggested that in many urban and suburban practices the two breeds most commonly affected with ear disease at the present time are Poodles, especially the Miniatures and Toys, and the Cocker Spaniel, followed by the wire-coated Terriers. It is scarcely necessary to add that any dog, of whatever breed or none, may be the subject of ear disease, but a study of the foregoing factors suggests a definite predisposition within certain types.

The Role of Bacteria in Canine Otitis

Many cases of external ear diseases show evidence of bacterial infection and it is important to attempt to assess the part played by bacteria in causing abnormalities. Much work has been done on the bacteriology of the healthy and diseased canine ear, and since the organisms found in a high proportion of the latter are identical with (or at most have some cultural modification) those isolated from clinically normal ears, it seems reasonable to assume that commensal organisms only assume a pathogenic role when some other factor has predisposed the integument to infection.

Numerous bacteriological surveys have been undertaken in various parts of the world and these show a surprising degree of agreement in their findings.

I am greatly indebted to Dr. Gordon Fraser for making available to me the results of a considerable survey undertaken by him recently, of both normal and clinically diseased ears. The results are as follows.

Species	70 healthy external ears of 35 clinically healthy dogs	523 external ears of 363 dogs affected with external otitis
Pseudomonas	–	13
Proteus	–	16
"Coliforms"	6	13
Haemolytic streptococci ...	3	18
Non haemolytic streptococci	30	25
Staphylococci	54	61
Corynebacterium	16	17
Aerobic sporing bacilli ...	31	12
Anaerobic sporing bacilli ...	44	42
Pityrosporum species ...	36	44
Other yeasts	4	6
Fungi	11	12

These figures show the percentage incidence of the more frequently occurring micro-organisms.

It will be noted that, whilst Proteus and Pseudomonas occurred only in clinically infected ears, Staphylococci and Pityrosporum could be isolated almost as frequently from clinically normal as from abnormal ears. A higher proportion of Staphylococci from affected ears coagulated rabbit plasma than those isolated from believed normal ears.

Fraser suggests that infection with Pseudomonas, Proteus and coliform organisms is either from an external source or by auto-infection from the intestines.

A small survey carried out by students at the Royal Veterinary College gave very similar results, a β-haemolytic *Staphylococcus albus* being the commonest organism in both healthy and diseased ears. An unidentified yeast was also isolated—judg-

ing from comparable surveys elsewhere this may well have been Pityrosporum. Pseudomonas (2) and Proteus (1) were found in 3 ears in association with Staphylococci or yeast.

It seems highly probable that the actual presence of bacteria in the ear is not significant, but that when the epithelium undergoes pathological changes due to any of a variety of causes many of these organisms can become pathogenic and cause active infection to occur.

As in the case of the skin, bacterial infection of the external ear canal must be regarded as a potentially serious clinical sign and active and vigorous therapeutic measures should be instituted to deal with it. While no case of otitis which shows bacterial involvement can be cured without adequate antibacterial therapy it is not necessarily true to say that once infection has been overcome, the ear is cured; it always remains to determine, if possible, the predisposing factor which allowed infection to develop and then to deal with it accordingly.

Factors which may allow secondary infection to develop include: inadequate ventilation, foreign bodies, excessive hair growth, excessive glandular activity, entry of irritant solutions (*e.g.* during swimming or bathing), bacterial infection of other parts of the integument, lowered resistance due to systemic infections such as viruses of the distemper complex, and infection of the middle ear.

Treatment required may be general, local, or both, and the modern availability of a wide range of antibiotics and chemotherapeutic agents has made the task of rendering the external auditory meatus bacteriologically innocuous much easier; this, however, will be mentioned more fully under the treatment headings.

Principles of Treatment

To assert that the object of treatment is to return the abnormal auditory canal to normal would appear again to be insultingly obvious, yet it is but rarely that this aim is fully achieved. It is absolutely essential to assess each case on its individual merits and, having in mind the normal integument, to set out to deal with it stage by stage until normality is believed to be restored; the suppression of clinical symptoms is not enough to warrant an assumption of recovery. Many dogs which show no evidence of persisting discomfort have an integument still far from normal and it is in these cases that it may be difficult to persuade an owner that further examination and treatment is needed.

It is needless to detail the routine of examination. It may in some cases be considered wise to withhold auriscopic examination for a short time until acute infection or painful lesions of the more superficial parts of the canal have been treated. In almost all cases auriscopic examination is vital to decide that treatment has been fully effective; failure to examine the depth of the canal following apparently successful treatment may result in quick recurrence. As with auscultation of hearts, interpretation and clinical classification of the lesions seen is largely a personal one and no overall definition can be entirely satisfactory.

Rigid adherence to a small number of favoured treatments is bad practice. Nothing requires greater flexibility of approach than canine ear disease; frequently, treatment may require to be changed several times during the course of a given case, and the permutations of types of treatment are endless. Use should be made of the full scope of present-day therapy, ranging from the latest antibiotic to the old and proved remedies of many years ago, some of which have stood the test of time and still deserve a place in modern practice. Personal preference in approach will vary widely. There is general agreement that thorough cleansing of the ear canal is frequently necessary for successful treatment. This cleansing may be achieved in many ways: by irrigation with soap and water, by the use of tampons of cotton-wool in forceps, by bland oily solutions and so on; each method has its protagonists. In the majority of cases the use of an oily based lotion containing something to loosen and soften debris, *e.g.* linimentum salicylicum (prescription 1) by pouring into the canal, massaging and kneading the canal from the exterior in an upward direction will bring most of the material to the surface where it may be swabbed out with cotton wool. The use of forceps need not be completely eschewed; used with care a great deal may be achieved by this means. A careful auriscopic search should be made for the presence of foreign bodies which, if of some duration, may have passed into the horizontal canal and will only be detectable in the anaesthetised dog. Similarly, in the author's view, general anaesthesia is desirable in those cases where forcible syringing is considered to be necessary.

In cases where bacterial infection exists this must be the first priority for treatment. Systemic antibiosis is often valuable and appears surprisingly often not to be resorted to in suppurative otitis. Local antibiotic or chemotherapeutic agents are best applied in the form of the various intramammary formulae; these have the advantage that the active principle is present in high concentration and in a *non-irritant base*. Penicillin, with or without streptomycin, remains first choice for systemic use, broad spectrum antibiotics being preferred for topical application, *e.g.* aureomycin, tyrothricin, neomycin.

After adequate anti-bacterial therapy, anti-inflammatory drugs of the cortico-steroid group may be valuable, particularly in cases showing chronic hypertrophic changes. Calamine lotion, with or without the addition of zinc oxide, starch and spirit remains a useful dressing; Calamine lotion may also be used as a vehicle for a sulphonamide powder in suspension—this is a most valuable dressing in suppurative otitis of the wet eczema type. Salicylic acid in various preparations may reduce the activity of ceruminous and sebaceous glands, while procaine or benzocaine in a zinc ointment base or oily excipient will be of value in cases where extreme irritation or pain is a factor. The natural slight waxiness of the normal integument may be restored by bland agents such as liquid paraffin if powders in suspen-

sion have left the ear dry and caked. Conversely, a thin film of calamine and/or zinc oxide may be necessary after the use of greasy dressings to restore normality.

Powders as such are rarely used owing to their failure to reach the depth of the canal, and the tendency to cake there when they do.

Solutions of silver nitrate have been used with success in certain suppurative and ulcerative types of case.

In all cases where the conformation of the ear canal is good and the integument has not undergone gross hypertrophic changes, medical treatment should be given a full trial. All dressings should be in a form which will penetrate to the depth of the canal and spread over its surface evenly.

In all dogs with much hair growth within the canal, especially Poodles, regular depilation from an early age is essential; this is preferably carried out mechanically with epilation forceps or the fingers. Chemical depilatories such as barium sulphide are occasionally used, and may be necessary for successful hair removal especially in very soft-haired types, but should never be applied in cases where inflammatory changes or infection already exist since these agents are themselves capable of producing inflammation. Such depilation may prevent subsequent inflammatory changes but even in cases where otitis already exists depilation at as early a stage in treatment as is feasible is absolutely vital.

Surgical

In many cases surgical treatment will be required. This is true of many chronic cases in several categories, *e.g.* ulcerative, suppurating and hypertrophic.

The primary operation will be that of aural resection. Several techniques and modifications have been described but the author adheres firmly to the technique advocated and taught by Professor J. G. Wright and has not adopted any of the more modern innovations. Considerable experience has shown that this technique, if carried out correctly, gives entirely satisfactory results, provides full drainage. is simpler and therefore quicker than the modifications, and finally involves less tissue and thus causes less shock, a factor which seems to alarm some surgeons.

The main requirements of Wright's technique are firstly to ensure that the initial incision is carried sufficiently far downwards to result in the lower aspect of the annular cartilage being fully exposed, and secondly to remove sufficiently large triangular areas of skin from the anterior and posterior aspects of the wound to draw the edges of cartilage well apart from one another when sutured to the new skin edges (see diagrams page 1125). Properly performed this operation is simple and effective; care must be taken to remove adequate skin, and also over suturing; no cartilage is removed other than to trim away any small protruding edge after suturing is complete. The suture material most favoured by the author is braided nylon, sizes 4 or 6 lb. breaking strain, since monofilament nylon is apt to cut through the tissues which need to be carefully and firmly drawn together for a good result. The objections made to this method, *i.e.* of damage to the facial nerve and involvement of the parotid gland are, in the author's view, not valid. In some 20 years' use of this technique no case of damage to the facial nerve can be recalled; it is but rarely that the incision encroaches upon gland tissue and on such occasions no adverse results have been noted. Accuracy over the initial incision and subsequent suturing will ensure full exposure of the horizontal canal and thus good drainage.

In most cases resection alone is sufficient to obtain resolution, but where gross hypertrophy has occurred and where the thickened integument has become so irritable that a scratch reflex is still present at medium depth anaesthesia, it may be necessary either to excise some of the larger folds or to curette the epithelium vigorously, subsequently cauterising with heat or solid silver nitrate. These procedures may be carried out at the same time as the resection or on some subsequent occasion when it has become obvious that a spontaneous return to normal will not take place. Excellent results are achieved by these somewhat drastic methods.

Classification

Ear disease will be considered under the following headings:—

1. Hyperaemia.
2. Allergic pruritus.
3. Ceruminous otitis.
4. Suppurative otitis, primary and secondary.
5. Ulcerative otitis.
6. Foreign bodies.
7. Parasitic.
8. Chronic suppurative otitis associated with bacterial dermatitis.
9. Chronic hypertrophy.
10. Seborrhoeic otitis.
11. Other lesions.

It must, however, be emphasised that classification of diseases of the external ear canal of the dog is very largely an individual matter; furthermore, any given case may well be placed in different categories according to the stage at which it is first seen. It is but rarely that a case seen by a competent clinician from the outset will ever reach the stage of chronic hypertrophic changes, provided the owner has co-operated in treatment; conversely it is impossible to classify as anything other than chronic, cases seen for the first time in which such changes are already present since the initial type of lesion can only be the object of surmise; cases of this latter type will only be seen initially following inadequate treatment or owner's neglect.

1. Hyperaemia

Seen in dogs of any age or breed, uni- or bilateral symptoms comprise intense irritation manifested by scratching or shaking; the irritation may be worsened by warmth or movement.

Examination of the ear canal shows the integument to be flushed a deeper pink than normal; the reddening may be confined to the superficial parts of the

canal or may extend as far as auriscopic examination can illuminate. No abnormal discharges or accumulation of hair or debris are present.

Treatment by simple methods such as the daily application of calamine lotion will usually suffice.

2. Allergic pruritus

Very similar to the previous type in that the only sign may be some reddening of the canal lining; even this may be intermittent and frequently examination reveals an apparently normal ear. Fairly severe irritation is a constant sign and owners may comment upon the fact that the ear appears "very red" at times. This is probably a hyper-sensitivity reaction of the contact allergy type and ear irritation may be present when other signs of skin hypersensitivity are absent. Response to anti-histamines is good, especially by parenteral administration; local applications are not always necessary but in some cases topical preparations of anti-histamine drugs may be of value. The exhibition of an anti-histamine is warranted in cases where an owner reports constant evidence of ear irritation by the patient yet repeated examinations reveal no departure from normal.

3. Ceruminous otitis

Abnormal activity of ceruminous glands with consequent production of excessive quantities of wax is a common sign of external ear disease, or may be itself the cause of such disease.

On the evidence at present available it is impossible to determine whether this hyperactivity is the result of an inflammation due to some other cause or whether the presence of unusually numerous ceruminous glands and their secretions are themselves the cause of such inflammation. Whichever is the train of events there can be no doubt that ceruminous otitis is a clinical entity. This condition occurs in all types of ears and from an early age. In ears of the disease-prone type more serious lesions are likely to ensue than in those of good conformation, *e.g.* hairy ears will cause the cerumen to be massed into concretions under which infection or ulceration can occur; likewise in narrow ear canals cerumen is deposited between the rugae and so predisposes to bacterial infection and inflammatory changes.

Thus there may be cases in which the only abnormality is the presence of excessive cerumen; those complicated by bacterial infection, and those in which chronic inflammatory changes or ulceration have occurred.

In all cases careful auriscopic examination to determine which of these states exists is essential. Treatment must initially comprise thorough and repeated cleansing of the canal, depilation at an appropriate stage, the use of anti-bacterial agents to abolish secondary infection and finally the use of drugs, such as salicylic acid, which may reduce the production of cerumen. Extensive ulceration or hypertrophy of the integument may necessitate resection.

4. Suppurative otitis or otorrhoea

Despite previous assertions that bacterial infection is always secondary to some other factor, clinically at least, cases can be divided into primary and secondary. Primary suppurative cases are those in which pus is present from the outset and this group may again be sub-divided into:—

(a) Superficial pyogenic infection of the aural canal in which the lesion resembles, and behaves like, acute wet eczema of other parts of the skin. When auriscopic examination is feasible (intense inflammation and pain renders this inadvisable too early in the case) it is usually found that the deeper parts of the canal are relatively normal. Rapid resolution of these cases is usually obtained by the use of a proprietary sulphonamide powder containing sulphanilamide, sulphathiazole, methyl violet and urea suspended in calamine lotion (Prescription No. 2). This dressing appears in most cases to be extremely soothing and results are usually most pleasing.

(b) Pyogenic infection of the depth of the vertical and the horizontal canals.

This, again, may be sub-divided, since some cases are associated with middle-ear disease and a perforated tympanum. Uncomplicated cases of deep-seated suppurative otitis may respond to antibiotic or chemotherapeutic treatment. In all such cases the use of a systemic antibiotic is advisable; a common routine is a 6 to 10 day course of penicillin or penicillin and streptomycin in full dosage parenterally, accompanied by the use of a broad spectrum antibiotic by topical application, *e.g.* Auroemycin, Terramycin, Tyrothricine, Polymixin, Bacitracin.

In cases where evidence of infection undergoes remissions and exacerbations middle-ear disease should be suspected.

In either group resistance to therapy or frequent recurrence should be the signal for surgical intervention.

Zepp (1950) claims that cases of middle-ear infection and perforation of the drum are cured by drainage; with this the writer cannot wholly agree since recurring periods of purulent discharge occur in many such cases following resection, none the less the symptoms of general malaise which may accompany this in the unopened ear are obviated in resected ears and furthermore adequate dressing is much easier and more complete.

Secondary suppurative otitis may supervene in many other types of ear disease such as the ceruminous type already mentioned, the presence of foreign bodies and so on. In such cases treatment must first be directed at abolishing pyogenic organisms and subsequently at dealing with the underlying cause. Proteus and Pseudomonas infections prove most resistant to treatment.

5. Ulcerative otitis

Ulceration of the integument may occur in several types of ear disease and is thus obviously to be found in cases which for any reason have not received effective treatment and so are of some duration.

Irritation is accompanied by pain, often evinced during examination. Ulceration may be detected by ordinary examination if it is fairly superficial, in the depth of the canal by auriscopic examination, and finally may be deduced from the presence of blood on an exploratory swab.

Two types of ulceration occur, one comprising large, irregular areas of abraded tissue, usually on the prominence of the convolutions and probably due to mechanical contact. The second type shows numerous, discrete circular ulcers, slightly raised above the surrounding integument; these are probably a response to chronic bacterial infection.

Ulceration may respond to the use of stimulant dressings such as silver nitrate, following treatment of whatever is the predisposing condition, but frequently proves intractable and necessitates surgery; resection of ulcerated ears is usually most rewarding.

6. Foreign bodies

In most suburban and urban areas the grass known as wall barley (*Hordeum murinum*) is prolific. One or more awns or even whole ears of this grass when dry and ripe frequently gain entrance to dogs' ears and cause much distress and disease especially during late summer.

Dogs with hanging, heavily feathered ears such as the Cocker Spaniel are most liable to acquire these awns, which are able to travel against the hair and so gain entrance to the canal; prick-eared dogs which have a tuft of hair left growing in front of the canal entrance (*e.g.* Scottish Terrier) are also frequently affected. Whilst any dog may get a grass awn in its ear it is decidedly unusual in smooth-coated types which have no long hair surrounding the ear at all.

In recent cases the history is typical, the dog showing sudden and acute ear irritation and pain during or shortly after a walk. Whenever possible such cases should receive emergency attention when it may be possible to remove the awn, before it has turned the corner into the horizontal canal, without resorting to general anaesthesia. In many cases general anaesthesia will be necessary.

In a small proportion of cases the early acute symptoms are either not noticed or are absent, and the dog will then usually be presented with a history of two or more weeks evidence of ear irritation. Pyogenic infection has often already occurred. It is worth investigating all such cases very carefully under anaesthesia.

In the London area, at least, grass awns are a most important factor in external ear disease and the necessity to eliminate these foreign bodies as a causal factor can hardly be over-emphasised. This may not apply in other parts of the country. In some cases which eventually come to operation after a history of long-standing ear disease awns may be found, covered in inspissated cerumen, adjacent to the tympanum.

7. Parasites

Otodectes cynotis has been incriminated by many workers. The author can only say that in her experience this parasite is a rarity in the canine ear. Alternatively, methods of diagnosis may be at fault, yet it seems odd that no suspected case has responded in any way to acaricidal dressings. Lacking personal experience of otacariasis in the dog, little of value can be said.

8. Chronic suppurative otitis associated with bacterial dermatitis

Commonest in Wire Fox Terriers and Cocker Spaniels in which co-incidental lesions will be found around eyelids and feet particularly, but also elsewhere on the body. The ear integument is grossly thickened and exudes a caseous type of purulent material.

The condition must be tackled as a whole by the vigorous use of broad-spectrum antibiotics, vitamins, etc. Prognosis is not good. Resection of the ears may have a useful palliative effect.

9. Chronic hypertrophy

Commonest in dogs with narrow, hairy ear canals and is the result of ear disease of some duration. Such cases are usually advanced when first presented and the original lesion may be difficult to ascertain.

Irritation is a marked feature of all cases of hypertrophy. Two types of thickened integument are recognised, that in which the whole rugae are grossly thickened resulting in a verrucosity, and that in which the epithelium becomes papillary in type and is intensely irritable to the touch. In both cases the situation is a vicious circle in that inflammation →hypertrophy→contact between surfaces→increased irritation.

In the verrucose type of hypertrophy the use of cortisone, with an antibiotic if infection co-exists, may give good results in some cases with considerable reduction of the inflammation and hypertrophy. Failure to respond necessitates surgery.

In the papillary type response to cortisone is disappointing and resection is nearly always necessary; it will be noted that even under surgical anaesthesia a scratch reflex can be evoked by rubbing the integument, so great is the pruritus. In such cases it is advisable to accompany or follow resection by excision of grossly thickened areas, thorough curettage and cautery, or cautery alone. Results are gratifying.

One case has been met in which the hypertrophy occurred between the integument and the cartilage resulting in a yellowish type of tissue which on histological examination proved to be dense bundles of fibrous tissue, inflammatory cells and giant cells: the aetiology is unknown. Resection has been of some considerable value.

10. Seborrhoeic otitis

Commonly exists in Spaniels and other thick-skinned breeds in which seborrhoea of other parts of the skin may be present.

The integument presents a moist exuding appear-

ance but without frank pus formation. The typical objectionable odour is usually obvious and indeed may be the only factor drawing the owner's attention to the ears. Irritation and pain are not marked. Treatment is as unsatisfactory as is that of seborrhoea in general, astringent dressings being of most value.

11. Other lesions of the external ear canal

Neoplasia appears to be rare in the canine ear. Papillomata may occur at all levels in the canal and are dealt with in a routine manner.

Chronic granulomatous lesions adjacent to the tympanum have been met which histologically prove difficult to differentiate from carcinomata; clinically these lesions respond reasonably well to removal of the diseased tissue and cautery.

THE CAT

External ear disease is both common and important in the cat but it is probably rather more easily classified than in the dog, with less minor variations. Parasitic otitis accounts for a very high proportion of all feline cases and the remaining categories may be compressed into: suppurative, primary and secondary; chronic inflammatory and neoplastic.

Anatomically and on conformation there is a close parallel with the dog but with no variations between breeds and types, and histologically there is probably even less known than for the dog, if that is possible.

The Normal Ear

Anatomically the external ear is very similar to that of the dog save that the free part of the concha is always carried rigidly erect; the size of the flap may differ slightly, tending to be larger in the long-faced short-coated varieties and smaller in the flatter-faced long-coats. The canal is funnel shaped and has vertical and horizontal parts as in the dog.

The normal integument is only very faintly pink or parchment coloured, it bears virtually no hairs and is again slightly glazed or waxed in appearance and sometimes frankly oily.

Bacteriology

On the very limited data available at the time of writing it appears that the cat's ear may frequently be bacteriologically sterile, in contrast to that of the dog. Non-haemolytic Staphylococci, coliform organisms and Streptococci have been isolated, and whereas *Pasteurella septica* was found in only 0.6 per cent. of infected canine ears, it is not infrequently associated with feline otitis (Fraser, 1958). An unidentified fungus has also been isolated from an apparently normal ear.

This bacteriological picture, vague though it is, can be correlated with the dramatic response to penicillin obtained clinically in most infected cats' ears.

Parasitology

It is well known that *Otodectes cynotis* is extremely common in the feline ear. Whilst it is true that cases may be seen in which some sort of balance appears to exist between parasite and host tissue in that severe symptoms and signs may be absent, it is probably proper to regard Otodectes as being always pathogenic and to deal with it accordingly.

Classifications

1. Parasitic otitis or otocariasis

Is always due to the presence of *Otodectes cynotis* in the external auditory canal.

Clinical manifestation of disease may be noted from a very early age, it being not uncommon to find kittens infected whilst still with, or immediately after leaving, the dam.

Symptoms. Scratching of the ears is always noted to some extent, but the severity of symptoms is extremely variable and is not in any way correlated with the extent of infestation, cats with exceedingly heavily parasited ears sometimes showing little discomfort.

Occasionally a cat will be presented which is said to be scratching the ears yet on examination the external ear seems blameless; such cases may prove to be notoedric mange with the main lesions on the forehead immediately anterior to the ears, hence the confusing history.

Diagnosis is extremely easy; in many cases the mites may be seen with the naked eye, can easily be seen using a hand lens, and microscopic demonstration is simplicity itself.

The lining of the external ear canal reacts to the presence of the mite by producing a dark brown, rather hard exudate, not dissimilar to canine cerumen in appearance. The amount of exudate produced varies very widely, tending to be greater in young animals. As all clinicians know, the size of the concretions removed from the ears of small kittens can be quite incredible.

Pyogenic infection is a fairly common complication of parasitic otitis.

Treatment is by the vigorous but judicious use of acaricidal agents.

By far the best of these, in the author's opinion, is a proprietary lotion containing dimethyldiphenylene-disulphide. This lotion has both a keratolytic and anti-parasitic action; it is extremely potent and over-enthusiastic use can cause tissue reaction. For that reason it is desirable for the veterinary surgeon to undertake dressing personally; the lotion may be used for the initial cleansing (except in suppurating ears) as well as being the residual dressing left in the ears; 3 to 5 dressings at 7 to 10 day intervals will cure almost every case. Should interim dressings by the owner be deemed advisable in severe cases a proprietary otodectic mange dressing containing 0.175 per cent. gamma benzene hexachloride and 0.5 per cent. benzyl cresol may be used on alternate days; in less severe cases the use of liquid paraffin is most beneficial. It is highly desirable to leave and maintain the integument in a greasy condition after treatment and liquid paraffin is ideal for the purpose: the author believes that the parasite finds

difficulty in existing and multiplying on a greasy tissue.

So great is the author's faith in the lotion first referred to that whilst it was out of production during and just after the war extraordinary efforts were made to obtain and conserve a supply until it again became available! These efforts were successful.

The efficacy of dimethyldiphenylene-disulphide was well demonstrated in a single experiment in which live Otodectes were placed on several slides and various agents applied to them including sulphur in, rape oil, ether, tincture iodi. fort. and benzyl benzoate amongst others; dimethyldiphenylene-disulphide was the only one to kill the mite within 5 minutes.

2. Suppurative otitis

(a) *Primary.* The onset of acute suppurative otitis can be very sudden, the cat showing all evidences of generalised illness with considerable malaise, depression and temperature rise. The head may be carried low and the ears held slightly outwards; shaking and scratching of the ears is not usually marked, probably due to their exceedingly painful state.

Examination will usually reveal external ear canals full of pus, or even pus overflowing and matting the adjacent fur. The integument may be necrotic and sloughing.

Response to penicillin is usually dramatic; the antibiotic should be administered parenterally as well as locally; for the latter purpose the intramammary cerates are outstandingly useful. Cleaning of the ear should be delayed for 48 hours when healing will already be commencing and the necessary manipulation is well tolerated by patient and tissue alike. Initial local treatment should consist only of light swabbing away of the pus presented at the surface, with the introduction of a few drops of a suitable intramammary penicillin into the canal, this to be repeated by the owner several times daily.

A chronic form of bacterial infection appears to occur in older cats. There is much pruritus and consequent scratching; on examination the ear canal appears dry and dusty or flaky; the appearance is not dissimilar to mild otocariasis but mites are not demonstrable and response to penicillin is usually excellent, local treatment alone sufficing.

Suppurative otitis may be associated with otitis media, which in the cat usually gives rise to some characteristic neurological signs; furthermore, the pus is usually confined to the depths of the vertical canal and rarely wells up in pools as in acute otitis externa. Recurrence of suppurative episodes should lead to suspicion of middle ear disease. Conversely (and although outside the scope of this paper) it must be remembered that occult middle-ear disease is not uncommon in the cat and that severely infected middle-ears can exist with no manifestations in the external ear at all.

(b) *Secondary.* Is always secondary to otacariasis and may complicate the treatment of that condition. It is met commonly in neglected cases in younger cats; it is not usually associated with systemic symptoms but ear pain is obvious. In such cases initial cleansing of the ear is essential despite the severe damage suffered by the integument in the process. Large areas of epithelium are sloughed off and haemorrhage is often quite considerable.

It is desirable initially to overcome bacterial infection by penicillin therapy, usually only necessary for a period of a few days, and subsequently to have recourse to acaricidal agents.

In any case of suppurative otitis which has become chronic due to inadequate treatment, or in cases of frequent discharge of pus from middle ear infection, surgical drainage may be essential.

Aural resection is a perfectly feasible procedure in the cat and is carried out by the technique already described. Owing to the comparatively small calibre of the meatus and the fact that it is rather more deeply sited in the cheek tissues than in the dog the apparent result may not be so pleasing; healing may also be slower due to the great difficulty of accurate suture placing at the ventral limit of the incision. None the less, resection is well worth while in certain cases and should be carried out.

3. Chronic inflammatory otitis

This may be of bacterial origin as mentioned in the previous section, or may appear to be of a hyperplastic nature with the production of granulomatous lesions not always readily distinguishable from neoplasms.

If low grade infection is present, response to antibiotics is good; if of a purely inflammatory nature, surgical removal of hyperplastic areas with subsequent cautery may be useful.

4. Neoplasia

The cat is distinguished by being prone to a tumour of the ear canal which is rare in all other species including man, namely the ceruminous adenocarcinoma (Cotchin, 1957). Whilst not always easy to differentiate from hyperplasia, this tumour can behave occasionally as a true carcinoma and metastasise.

Polypi are not uncommon in the feline auditory meatus and are readily detected by auriscopic examination. Surgical excision, with or without aural resection according to the depth of the lesion, is extremely satisfactory.

It may be felt that the rather conservative range of suggested therapeutic measures contrasts strangely with the much wider and more varied approach in the dog. Experience has shown, however, that the recommended acaricide is far superior to any other agent so far tried and that response to penicillin in cases of pyogenic infections is so regularly satisfactory that there seems no need to resort to other antibiotics which may be less innocuous in use. Thus dimethyldiphenylene-disulphide, penicillin and surgery would seem to the author to be virtually a complete therapeutic armoury for diseases of the external auditory meatus of the cat.

TYPES OF CONFORMATION

FIG. 1.—Wide, roomy, funnel-shaped vertical canal. Good conformation, not disease prone.

FIG. 2.—Narrow, cylindrical vertical canal. Rugae exaggerated and almost touching. Small calibre horizontal canal. Bad conformation predisposing to otitis externa.

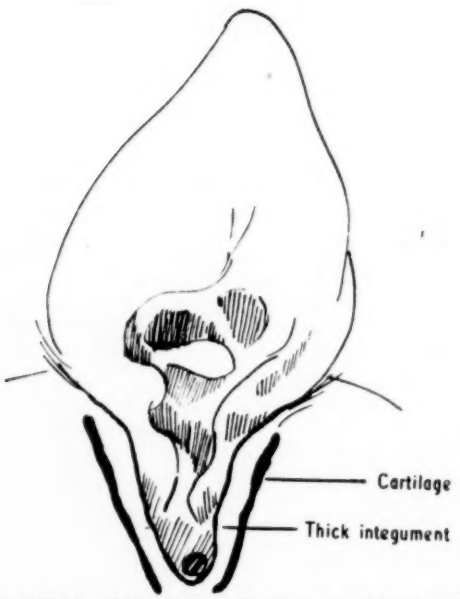

FIG. 3.—Thick epidermal tissue lining canal. Seen in thick-skinned breeds. Prone to seborrhoeic conditions of the meatus.

TECHNIQUE OF AURAL RESECTION

FIG. 4.—With groove director inserted into canal incision is made through all layers of tissue as indicated by dotted line. Incision *must* reach lower limit of annular cartilage.

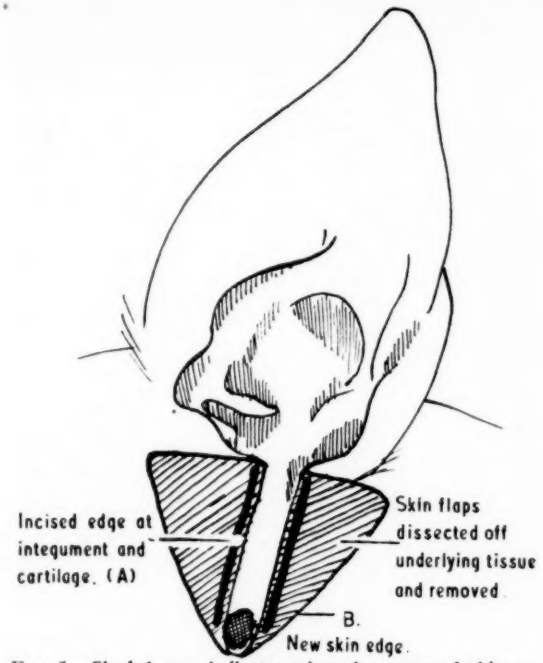

FIG. 5.—Shaded area indicates triangular areas of skin removed, having been dissected off underlying tissues. Size of triangular skin flap must be assessed according to the calibre of the ear canal and the conformation of the head, especially the depth of cheek tissue.

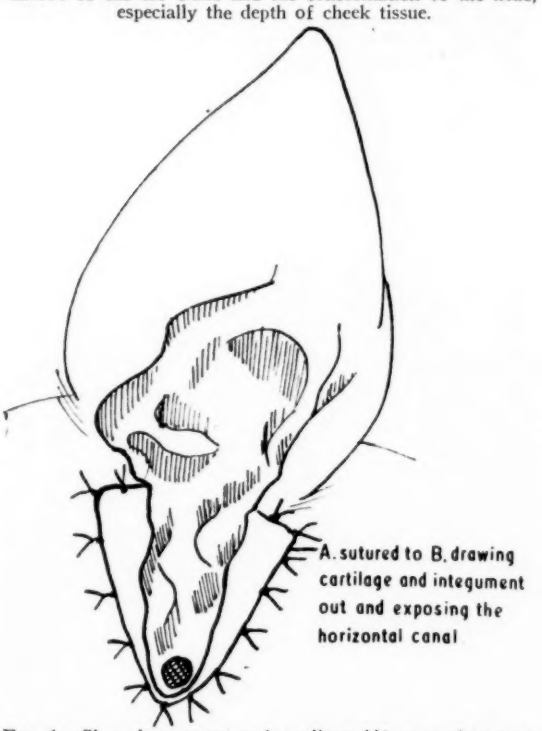

FIG. 6.—Show integument and cartilage (A) sutured to new skin edge (B) thus drawing the walls of the meatus away from one another and exposing the horizontal canal to permit drainage.

Summary

The paper is introduced by suggesting that, despite the prevalence of external ear disease in the dog and cat and the importance of the condition in small-animal practice, relatively little fundamental research has been undertaken.

A survey of recent literature indicates that attention has been paid to bacteriology, which is in fairly general agreement, surgical treatment and a wide variety of medical lines of therapy, but that there is scant literature surveying the subject as a whole.

Reference is made to the normal integument of the external auditory meatus, its variation in different breeds and coat type groups, and to what is known of the normal histology.

Possible factors predisposing to ear disease, such as conformation of ear canal, skin and coat type, breed incidence, etc. are mentioned.

A purely clinical classification of types of disease of the external auditory meatus is attempted.

Medical and surgical treatments are discussed with emphasis on the necessity to consider each case on its individual merit and to avoid the adoption of a routine approach in therapy.

Ear disease in the cat is discussed under the heading of types of external ear disease with emphasis on the importance of parasitic otitis. The bacteriology of the cat ear is mentioned.

Methods of medical and surgical treatment are described.

Acknowledgments.—I have not hesitated to ask for the assistance of a number of my colleagues in preparing this paper and in every case most generous help has been given.

I am particularly indebted to Dr. Gordon Fraser for placing at my disposal the results of his bacteriological survey, and to Mrs. E. Cotchin for preparing the diagrams.

I also wish to acknowledge assistance from Mr. J. E. Smith, and through him to thank the following students of the Royal Veterinary College, Miss P. A. Alexander, Messrs. R. Bradley, J. B. Baber, P. Jackson and D. W. Marriott for making available to me the results of bacteriological surveys carried out by them under Mr. Smith's supervision.

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Appendix

Some prescriptions and proprietary preparations mentioned in the text.

1. Linimentum Salicylicum.
   R/
   Ac. Salicyl ... ... 1 oz.
   Spirit. vini. meth. ... ... 4 „
   Ol. Ricini ... ... ad 20 „
   Useful for cleaning ears and reducing cerumen production.

2. R/
   Ac. Salicyl ... ... 60 gr.
   Sol. Picis. Carb. ... ... 60 m.
   Glycerin ... ... 120 m.
   Water soluble ointment base ... 4 ozs
   Also useful in ceruminous and seborrhoeic ears.

3. R/
   Cooper's Wound Dressing Powder 120 gr.
   Lot. Calaminae ... ... 2 oz.
   Wound Dressing Powder (Cooper, McDougall & Robertson) contains :—
   Methyl Violet ... ... 0·1 per cent.
   Sulphathiazole ... ... 3·0 „
   Sulphanilamide ... ... 15·0 „
   Urea ... ... 79·9 „
   Inactive ingredient ... ... 2·0 „
   This lotion is of great value in acutely suppurating ears, especially when the inflammation is relatively superficial in the ear canal.

4. Ung. Procain. Co. (Hewlett)
   A proprietary ointment which contains :
   Procain. Hydrochloride ... 5 per cent.
   Zinc oxide. ... ... 10 „
   Liq. Adrenalin. Hydrochloride 6·25 „
   Is of value as an initial treatment is many painful and irritable ear conditions.

5. " Anaesco " Ear Drops (Hewlett)
   A useful oily lotion containing 1·5 per cent. Procaine ; of value in similar conditions to previous preparation but when a more penetrating vehicle is required.

6. Solutions of Silver Nitrate.
   2 to 10 per cent. solutions of silver nitrate in distilled water are of value when a stimulating anti-inflammatory dressing is required ; well tolerated by most dogs but care must be used in selecting the appropriate strength.

7. Dimethyldiphenylene-Disulphide. " Odylen " (Bayer).
   Outstandingly useful in otoacariasis of the cat.

8. Otodectic Mange Dressing (Cooper, McDougall & Robertson).
   Contains 0·175 per cent. " Gammexane," gamma benzene hexachloride.
   A parasiticidal dressing useful for application by the owner in feline otoacariasis.

THE SPEAKER'S INTRODUCTION

Miss J. O. Joshua, in introducing the paper, referred to two articles : one which had come to her notice after preparation of the paper and another one which had just been published. In the first, an article by Nielsen on the histology and glands of the skin, there was the following brief reference to the glands of the ear canal :—

> " These are apocrine and sebaceous, of similar structure to those of the skin but present in larger numbers. The apocrine glands in the ear canal are called ceruminous glands. The normal secretion, the cerumen, is a product of both glandular types and in a healthy ear canal it appears as a fairly dry, dark brownish substance, differing from the yellow waxy cerumen of the human ear. When hypersecretion and inflammation occurs in the canine ear, we find histologically a marked hypertrophy and proliferation of both sebaceous and apocrine glands. Whether the infection of the ear canal is the primary lesion with a consequent glandular hypersecretion due to irritation and inceased blood supply, or secondary to a hypersecretion with stagnation of secreta, is debatable."

This description differed markedly from that of Witter, referred to in the paper, but the views of Nielsen were more acceptable and she was in full agreement with him in the difficulty of deciding which came first, the inflammation or the hypersecretion. However, they were still left with a great deficiency in their knowledge of the pathological histology of diseased ears and she hoped that a plea for some worker in the country to do that piece of work would not fall on deaf ears—whether the deafness be due to accumulation of pathological secretions or not ! It was work which, while not exciting, would be of the greatest value to clinicians everywhere.

The second article to which reference must be made was that on "Otodectic Mange in the Dog," by Churchill Frost and Beresford Jones. The authors, dealing with 100 unselected cases of otitis externa in the dog found *Otodectis cynotis* in 36 of them by the methods of examination they described. She herself kept an open mind on that as she still failed to find cases in practice. Perhaps at a conservative estimate one made about 500 auriscopic examinations annually and it was disconcerting to think one could miss the parasite so frequently. One wished that the authors had seen fit to describe the lesions produced in the 36 cases so that they might know the type of otitis to look for ; also, that they had indicated their lines of treatment and the results. Was it wrong to think that the scarcity of mites per ear was significant? In 31 dogs there were fewer than 3 mites per ear, a startling contrast with the cat, in which clinical otocariasis was so frequent. More work should be done before they could assess accurately the clinical significance of the presence of the odd Otodect in the canine ear.

In underlining a few points made in the paper, Miss Joshua referred first to the necessity to consider types of ears when judging proneness to disease and possible response to medical treatment, and then to correlate coat and skin types with the forms of otitis met in certain breeds. In the matter of treatment she would reiterate the necessity for a flexible approach, making full use of the amazing range of therapeutic agents available to-day. She personally loathed and detested blunderbuss therapy in ear cases, and must be a bane to representatives of drug firms who went merrily into her surgery and said they had now added so-and-so to their ear drops, whereupon she usually exploded ! It was vital to deal with any ear case stage by stage, using the appropriate drug for each stage and making such combinations of agents as seemed desirable from time to time. Where bacterial infection existed, no matter at what stage, treatment should initially be directed at overcoming it ; the use of antibiotic drugs systemically was of great value in many cases. Subsequent therapy was aimed at restoring the integument to normal. So far as surgery was concerned, one could only recommend those who had not used the technique described in the paper to try it.

Miss Joshua had found the cat a much easier species to deal with for ear trouble than the dog, as ear conformation varied little and the range of disease types was far smaller. Otocariasis was of prime importance and a cure should follow vigorous and well-directed treatment. Bacterial infections responded so well to penicillin in the cat that that antibiotic was in itself a tower of strength, and aural resection was also feasible.

No one was more conscious of the deficiencies of the paper than she was herself ; some were due to gaps in their fundamental knowledge, but many were due to her own inadequacy. She hoped and expected to learn much from such discussion as they might be kind enough to afford the paper.

The Opener

Mr. T. C. Denholm, in opening the discussion, said that one of the nicest things about speaking first was that it gave the opener the first opportunity of congratulating the

author. There was no doubt that Miss Joshua deserved a great deal of praise for her paper. It could not have been an easy paper to write and the very thorough way in which she had dealt with it could have resulted only from the expenditure of considerable time and thought on her part.

When asked to open the discussion he had viewed the prospect with no great alarm. The subject of ear conditions was so full of problems, abounding with conflicting ideas on diagnosis and treatment, and until now so neglected in their literature, that he felt sure it would not be too difficult to stimulate a lively discussion. Unfortunately, he found himself so much in agreement with Miss Joshua that he had been somewhat at a loss to find a basis for constructive criticism. It was impossible to exaggerate the importance of disease of the auditory meatus in respect of both the suffering caused to their patients and the difficulties confronting the veterinarian in the matter of treatment. Not the least of those difficulties was that of persuading the owner to continue with the treatment until complete recovery was attained. That might take some little time after, in the owner's opinion, symptoms had disappeared. The author made that point in her paper but it was well worth repeating. Many cases of recurrence were simply a flare-up of a condition never really cured.

In something over 1,100 small-animal patients seen in his practice in the month of June this year (June being a month when ear conditions were not particularly troublesome) just over 7 per cent. were presented by the owners because of symptoms of ear trouble. It was a fair bet that some proportion of the others had some degree of disease either unnoticed or unconsidered by the owner.

Miss Joshua had dealt at some length with what she called factors predisposing to disease, and he was sure they must all agree that the greatest single factor was the anatomy of the canal. Mother Nature never made a greater mistake than when the external auditory meatus of the dog and cat was designed. The whole system whereby two canals practically met at a right angle was simply calculated to cause trouble, particularly when, as in flop-eared dogs, the last straw was added and air was practically excluded from the site. The situation was further complicated by the presence in so many dogs of abundant growth of hair in the canal. It was his firm belief that if the breeders of the miniature Poodle persisted in producing puppies with a luxuriant growth of hair in the ear the breed would suffer a serious setback in popularity. The two aggravating conditions of flop ears and hairy ears contributed very largely to the causation of the majority of cases of disease of the external auditory meatus. Most of their patients were poodles, but only because they were at present the most popular breed, while the most intractable cases still occurred in the old faithful, the Spaniel. The truth of that was borne out by the improvement which in so many cases resulted from aural resection. Following surgery, thorough cleansing of the canal was possible and, furthermore, the considerable increase in ventilation had a most satisfying effect.

On the subject of resection he must differ from Miss Joshua, who claimed that the earlier method which she described was simpler and quicker and involved less tissue and therefore caused less shock than the more modern techniques; and, finally, that it provided adequate drainage. He would agree that it was simpler and quicker, but not that those considerations were very important when other factors were taken into account. He would even agree that it involved less distraction of tissue and consequent shock, not that that was serious with present-day surgical techniques. He did not believe that the simpler operation provided adequate drainage in all cases. In the long-haired dog in particular, subsequent growth of hair might almost completely occlude the canal which one had gone to such lengths to lay bare. The method described by Miss Joshua was undoubtedly satisfactory in many cases, but a proportion of cases required much more radical methods to ensure success.

He had found it impossible to decide before surgery which cases would respond to simpler surgery and which would require more courageous interference. It would seem only reasonable, therefore, to carry out the measures which would give the greatest chance of recovery in the greatest number of cases. In his experience it was necessary to remove, in addition to a large V-shaped piece of skin and soft tissue from each side of the incision, all the cartilage underlying that, leaving in fact only the medial wall of the vertical canal. There were obstacles, of course. Haemorrhage could be profuse, particularly in a long-standing case and, with the exception of some larger vessels which could be ligated, was best controlled by pressure with a swab, and patience, until the bleeding subsided. Considerable difficulty was experienced in separating the cartilage to be removed from the lining of the meatus, but again with patience and careful dissection it could be done. Finally, a great deal of tissue was involved and healing might be protracted, but the results were well worth the additional trouble and possible increased discomfort to the patient.

Classification of disease conditions could be something of a headache, and ear conditions were surely among the worst to classify. All the more credit was therefore due to Miss Joshua for her choice of headings under which to discuss the problem. If he could make any criticism it was only to say that perhaps she was guilty of over-classification. Conditions 1 and 2 seemed to be indistinguishable. One did undoubtedly meet with acutely inflamed ears which upon examination were found to be free of discharge, hair, foreign bodies, etc., and it was his impression that they were all of an allergic nature. Again, under the heading of suppurative otitis, the picture seemed to be unduly complicated. While discussing the rôle of bacteria the author reached the conclusion that commensal organisms assumed a pathogenic rôle only when some other factor had predisposed the integument to infection. That would seem to be a very reasonable assumption, in view of the bacteriological findings in healthy and diseased ears, but despite that, and even admitting it, it was claimed that cases of suppurative otitis might be primary or secondary. Primary suppurative otitis cases were defined as those in which pus was present from the outset. The outset of what? The Oxford dictionary defined "outset" as the beginning, start or commencement of a series of events. Did they ever see cases from the outset? Only a few hours might be necessary to produce changes in the integument sufficient to provide conditions suitable for the establishment of infection.

The superficial pyogenic infection described under subheading (a), and which was likened to acute wet eczema, was surely in fact just that—acute wet eczema. Could they really consider pyogenic infection of the depth of the meatus as anything but secondary?

With regard to middle ear disease, which came first, middle ear disease and rupture of the ear drum or suppurative otitis? If the middle ear was affected first, what caused it? Is it a complication of other conditions of the external meatus, and, if so, how did one diagnose it? Was there any truth in the belief that pouring a liquid into the ear of a dog with a punctured tympanum caused repeated swallowing movements?

Mr. Denholm questioned very much the value of the parenteral administration of penicillin or penicillin and streptomycin for 6 to 10 days. In his experience most infections of the ear in dogs were resistant to such treatment, or the response was only very limited. Would Miss Joshua tell them what she meant by "full-dosage"? Any success of his was in the simpler types which responded very rapidly to topical applications and hardly justified an expensive course of injections.

Miss Joshua's views on the incidence of parasitic otitis were interesting and surprising. It has been his impression that that condition was much more common than was realised, but that it was not of great importance except in so far as it was a predisposing factor in the onset of suppuration and ulceration. There was no doubt that infection from the cat did occur, and cross-examination of the owner often revealed the presence of a cat living in close contact with a dog. The surprising thing was that the owner would frequently assert that the cat had no ear trouble, but on examination quite badly affected ears would be found, even in young kittens. The conditions responded well to treatment unless the ears had become infected or undergone hypertrophy.

It was surprising to learn that grass awns were an important factor in external ear disease in the London area. They were undoubtedly most painful to the dog, sometimes difficult to remove and, for some unknown reason, usually gained access to the ear when the dog was taken out for his last walk of the day. It had been his impression that those cases were becoming less common, and this he had attributed to the intensive building programme with the consequently loss of rough land for the dogs to run on. However, he could not believe that the dogs in the London area had more grass than those elsewhere had, so perhaps there was some other factor. It would be interesting to hear the views of others on the incidence of that condition.

With regard to the cat, there was little one could add to the paper. As the author had stated, diseases of the external auditory meatus in that animal were exceedingly common, but were more easily classified and in general responded more readily to treatment.

He disagreed once again on the question of suppurative otitis, believing that it was almost always secondary to parasitic otitis, which was probably of long standing and might be quite unnoticed by the owner. It was remarkable how badly choked with discharge some cats' ears might be when symptoms were few or even completely absent. The few cases of suppurative otitis in cats which appeared to be primary normally occurred in the old belligerent tom cat, well scarred about the head and ears, who could quite suddenly blow up a suppurating ear which was extremely painful and which might give rise to quite alarming systemic symptoms.

Mr. Denholm said that he had deliberately avoided mentioning any of his pet dressings, simply because dressings were largely a matter of individual preference, but he would stress once again points which Miss Joshua had emphasised in her paper: thorough but judicious cleansing of affected ears; flexibility in choice of treatment, even to the extent, if found necessary, of using different preparations on opposite ears of the same dog; persistence with treatment until as complete a recovery as possible was achieved; frequent use of the auriscope; and finally, complete surgery, without hesitation, in cases which failed to respond.

He concluded by thanking the Provisional Committee for giving him the opportunity to open the discussion; hoping that he had justified their optimism and stimulated many lively comments from the floor. Once again he congratulated Miss Joshua on her paper which, in addition to being an excellent contribution to this Congress, must surely have earned a worthy place in their literature.

The General Discussion

Mr. J. W. Bruford (Sevenoaks): "I should like to thank the author for her paper which I have read with great interest. I am rather surprised, however, to find little or no reference to ectoparasites as being a precipitating factor in disease conditions of the ear. In our practice I would have no hesitation in saying that at least 75 per cent. of the cases were associated with trauma, either from scratching, rubbing, or shaking due to the presence of ectoparasites.

"While the Poodle may be the dog most frequently affected, I would place the Spaniel as being the most tiresome of all breeds to treat. The Pekingese is also quite commonly affected. In my opinion, ectoparasites are not only responsible for inflammation of the external auditory meatus but make dogs rub their heads in hedgerows and grass verges and are indirectly responsible for barley awns and the like getting into the ear. There is no doubt that *Otodectes cynotis* frequently invade the ear of the dog and because of rubbing are, like all ectoparasites, the cause of the hyperaemic, suppurative, and ulcerative conditions of the ear. It is wise, therefore, to examine the ears of other cats or dogs in the household before deciding that ectoparasites are not the primary cause of the trouble."

Mr. D. F. Oliver (Grantham): "It was not my intention to speak at this meeting but having heard the speaker's introduction and the opener's remarks I feel that I must pay tribute to the high quality of their contributions.

"I am not too happy about the frequent use of swabbing in the treatment of otitis but prefer to rely on irrigation as, for example, with Cetavlon, and to reduce swabbing to a bare minimum.

"In the discussion which has taken place so far this morning there appears to be a swing back towards the use of dry dressings in acute otitis. That there is a place for such dressings is made evident by the success of such proprietary dressings when other expensive treatments have failed.

"I should like to ask the essayist if she could enlarge at all on the aetiology of an acute form of otitis found in the cat. The discharge was clear and it responded spectacularly to antibiotics in cerates: was it an infection, or would the condition resolve itself if only the oily base were applied?"

Mr. S. Jennings (Glasgow): "I cannot let my friend John Bruford stand alone on the matter of parasites for, like him, I am convinced that otodectic mites play a big part in the primary cause of otitis in the dog. It is little wonder that the relationship is not generally recognised because the mites are soon lost in the discharge which they provoke in the ear and they are difficult to find. Unlike the cat which often harbours innumerable mites without showing much reaction, the dog appears to react to just a few.

"Some years ago when I was interested in this subject I used to use a small spoon curette which had had its sharp edges smoothed down. The ceruminous wax was collected in the spoon, dissolved and boiled in caustic potash and then filtered. In this way one or two mites could be recovered and they might well have been missed if less careful methods had been used."

The Replies

Mr. Denholm, in reply, said he had not meant to suggest that resection of the ear was a cure-all. It should not be undertaken lightly. In the past 2 years he had carried out a resection only about half a dozen times. If resection were undertaken it should be done completely and, combined with subsequent treatment, could result in complete recovery.

Miss Joshua, in reply, said she felt that the controversial nature of some of the points raised in the discussion entirely justified the whole session. The right-angled bend was a great mistake on the part of Nature, but since it was there they must cope with it! She, too, would like to breed out of Miniature Poodles the tendency to hairy ears: it could be done because one still came across Poodles with good ears and relatively little hair, and the type of meatus they had should be put to breeders as a genetic objective.

It was true that in resection one must modify one's technique while proceeding in each case. It was a means to an end, but in occasional cases a routine technique was not sufficient. Classification depended very much on the stage at which one saw the case; a single case would fit into different classifications at different times. Few veterinarians saw cases at the outset. It was questionable whether hyperaemia and allergic conditions were distinguishable, but they probably were. Conditions of hyperaemia responded to appropriate dressings whilst true allergic conditions did not, and the use of anti-histamines was sometimes necessary.

Middle ear disease was rather difficult to diagnose. In the dog it was nearly always secondary to external ear infection, in contradistinction to the cat in which it might exist primarily. Antibiotics were of value when given systemically, because the infection was in the depth of the integument and in many cases was not a surface infection. A need existed for more pathological histology.

Miss Joshua said she had to be convinced that her method of looking for parasites was obviously inadequate, and she would go back and try again. Grass awns were referred to because some veterinary surgeons and students were extremely surprised at their presence in ears, and the propensity for that seemed to intensify the more the area was built up. She had seen only two grass-awn cases during the summer due to the wet weather. This was most unusual.

Breed incidence was connected with popularity of breeds, and at the moment, at least in towns, the Poodle took the lead. Ear disease was not rare in Pekingese or Alsatians, but the condition was not so intractable in them as in some other breeds. Conservative treatment should be given before resection was resorted to; but there came to them all at times a case which had been neglected due either to inadequate treatment in the first instance or, more commonly, to the owner's refusal to co-operate right to the end. It was absolutely vital for cases to return to the surgery until the best possible result was achieved.

The over-dressing of ears should be avoided, but so many people were working nowadays that few could spare the time to call at the surgery every 24 or 48 hours to have dressings applied. Dry dressings were sometimes valuable. One colleague was fond of using powdered sulphonilamide, which obtained a good result in a proportion of cases but was something to be used with discretion. Some dogs used their claws pretty well, while others, with bad ears, did little in the way of shaking or scratching, but there was some difficulty in accepting Mr. Bruford's view on ecto-parasites in the ears. The use of swabs was quite permissible in certain cases.

She could not answer Dr. Cotchin's question as to the normal function of the secretions in the ears and what happened to them. One assumed that they got spread over the surface and some type of evaporation took place. It was difficult to know what was the normal kind of secretion that one should find. Many dogs had a quantity of secretion tucked away in the folds of the ear. They were like people who had an excess of wax which required removing from time to time though the condition was not seriously pathological.

On the provision of drainage, a good deal depended upon the calibre of the horizontal canal. No matter what technique was employed, if the calibre of that canal was small nothing would make it bigger. It was the small horizontal canal which gave poorish results after resection. Of all the aural resections she performed she regarded very few as failures. The majority were 100 per cent. successful; some were partially successful, particularly where there was continuing infection and repeated dressing would be necessary. But it was the calibre of the canal that mattered so much more than the technique adopted.

The Role of the Veterinary Surgeon in Public Health

BY
C. G. ALLEN
Chief Veterinary Officer, City of Birmingham

SUMMARY.—A definition of Veterinary Public Health is given and it is pointed out that foods of animal origin are essential for the well-being and health of man.

Veterinary surgeons are able to play an important part in public health work and should be given the opportunity of doing more.

This work consists of:—

(1) *Helping the farmer to increase the production of food animals.*

(2) *Preventing and where possible eradicating diseases in animals, some of which can be transmitted to man.*

(3) *Inspecting milch cattle and sampling milk to keep it free from infection.*

(4) *Inspecting live animals and carcases to prevent diseased or unwholesome meat from being used for human consumption.*

(5) *Supervising the transport, lairage, slaughter, and dressing of food animals.*

(6) *Enforcing the various regulations relating to food and animals.*

A REPORT issued by the World Health Organisation (1955) defines veterinary public health as "the field of activity which protects and advances human well-being by utilising the combined knowledge and resources of all those concerned with human and animal health and their interrelationships." Although it is said that there are over 80 infections of animals which may adversely affect human health, fortunately only a small number of these occur in Great Britain (Meyer, 1955).

It is not generally known that the veterinarian takes part in public health work; it is thought that he is concerned only with the treatment of animals when they are injured or diseased. Even pet animals may cause serious ill health to their owners, but veterinary public health mainly concerns the larger food animals. It should be understood that this work is not entirely undertaken by municipal or state veterinary officers, but quite a large share is carried out by veterinarians whose practices deal with food animals.

We have only to read of the tremendous cost of the national health service and add to this the large amount of money spent privately on patent medicines, to realise that every effort possible should be made towards the prevention of disease. It is an established fact that correct nutrition plays a most important part in maintaining the health of the people. Science has worked out our daily food requirements, but it is not just a matter of quantity; quality also is needed, and foods of animal origin such as flesh meat, milk, butter, cheese, eggs etc. are especially valuable. One of the obvious tasks for the veterinarian, therefore, is to eliminate disease in our food animals. This can only be accomplished by the combined efforts of farmers and veterinary surgeons. Until these diseases have been eliminated the state and municipal veterinary officers must be given the difficult job of preventing diseased or unwholesome products of animal origin from being used as food for human consumption.

Modern farmers not only call in the veterinary surgeon to treat sick animals, but also to advise on breeding and feeding, and on those problems concerned with the prevention of disease in their livestock. By increasing his production of healthy animals, the farmer receives a better return for the foodstuffs used, and the health of the consumer is improved because he obtains the maximum benefit from the final food products produced.

As local veterinary inspectors, veterinary surgeons in practice and those employed by local authorities assist the state veterinary officers of the Animal Health Division in the work of controlling and eradicating various contagious diseases of animals. Due to their combined efforts a number of these diseases have been eradicated from this country, for example, glanders, rabies, bovine pleuropneumonia, rinderpest and sheep scab. At the present time bovine tuberculosis is being actively attacked and will soon be eradicated. This must result in better health for both animals and man. The latest figure (March, 1958) shows that in Great Britain 76 per cent. of our cattle are now attested. In the Birmingham abattoir, in 1938, tuberculosis was found in 24 per cent. of the cattle slaughtered; in 1957 the percentage had dropped to 7.4.

An Early TB. Eradication Scheme

It is probably news to many in this audience that as long ago as 1908 a bovine tuberculosis eradication scheme was started by the Corporation of Birmingham, due to the efforts of the then Chief Veterinary Officer of the City, Mr. John Malcolm. Under this scheme free tuberculin testing of their herds was offered to farmers supplying milk to Birmingham, provided they would agree to get rid of reactors. The testing was carried out twice yearly, partly by the Corporation's veterinary officers and partly by the farmers' own veterinary surgeons. At first the test used was the old subcutaneous one, and by 1936 28 herds were in the scheme. In addition, through a special Corporation Act, power was given to Birmingham to take samples of milk supplied to

the city, and to go to farms whether inside or outside the city, for the purpose of taking further samples, and also for the making of orders prohibiting the sale of infected milk. To encourage the slaughter of cows found excreting tubercle bacilli in their milk, farmers were offered compensation by the Corporation. No tuberculin testing is now done outside the city, but samples of milk are regularly taken each week, to be examined for the presence of tubercle bacilli. Where these prove to be positive, notifications are sent to the divisional veterinary officers of the Ministry concerned and investigations are made at the farms. Any danger of infection being transmitted to man is, of course, removed by pasteurisation.

Tuberculosis is one of the main diseases looked for in meat inspection, particularly in cattle and pigs, but there are of course other diseases of animals which can be transmitted to man or, if not actually transmissible, can render the meat unwholesome.

Meat inspection is usually the main work of those veterinarians employed either whole time or part-time by local authorities. These officers are appointed for the purpose of the inspection of food and as authorised officers for the examination and seizure of meat, under the provisions of the Food and Drugs Act, 1955, relating to food unfit for human consumption. (Food & Drugs Act, 1955, Section 86.) This work consists of *ante-* and *post-mortem* inspection of animals and, where possible, laboratory diagnosis. In addition there are numerous regulations to be enforced dealing with hygiene, the control of slaughtering and slaughterhouses, and the transport of animals. The number of veterinary surgeons employed on meat inspection in England and Wales is far too small.

Meat Inspection and the Profession

For many years other countries, including Scotland, Ireland and continental countries, have recognised that the veterinary surgeon, by his training in the health and diseases of animals, is eminently fitted for this work. In common with many others our government insists on veterinary inspection for all imported meat, but, surprisingly, this standard is not required for meat produced in England and Wales.

I do not suggest for a moment that all meat inspection work should be carried out solely by veterinary officers; this would be uneconomic and impracticable. Such work is mainly undertaken by public health inspectors, often under great difficulties, due mostly to the large number of slaughterhouses both private and municipal, with no control of slaughtering hours and with many other public health duties to perform. However, it is work where decisions as to the fitness of meat for human consumption have constantly to be made, and where so many problems are met with that expert opinion is often to be desired. There have been cases where firms wishing to export meat or meat products abroad have had difficulty in obtaining the required veterinary certificates.

The whole time and part-time officers of the state veterinary service are well distributed throughout the country, and their knowledge and experience of animal diseases should be made available to local authorities generally. At present only a few authorities are able to have this veterinary service. The reports of these officers could be sent to the headquarters of the Animal Health Division of the Ministry of Agriculture, Fisheries and Food, and much valuable information, particularly on the incidence of disease, would thereby be collected.

The most difficult carcases to deal with, and those most likely to cause food poisoning, are from the emergency-slaughtered class of animals. *Ante-mortem* inspection often indicates that the animal is ill, but some cases, on *post-mortem* inspection, produce few lesions. These are the cases in which a bacteriological examination of the flesh is necessary, and where a laboratory attached to the abattoir is found to be so useful.

In connexion with these emergency slaughter cases, practising veterinary surgeons can help by giving the fullest information in the certificates which they issue to farmers sending carcases of sick animals to be inspected. The memorandum on meat inspection (1952), issued by the Ministry of Food, states that the certificate should give the reason for slaughter, and particulars of any drugs that have been administered to the live animal which might affect the carcase. Apart from this procedure in dealing with carcases of sick animals, if practising veterinary surgeons notify us before sending in sick animals for slaughter, giving similar particulars, we let them know what lesions have been found. Such co-operation benefits both parties.

Laboratory Aids

It is hoped that the once proposed system of moderate concentration of slaughtering will some day be possible, with better facilities for hygiene, *ante-mortem* inspection and laboratory diagnosis. The laboratory is especially useful in cases of suspected anthrax. All cases of sudden death in animals suggestive of anthrax are investigated and microscopical examinations are carried out by the veterinary officer. Where anthrax is actually found, the medical officer of health is notified, and persons who may have become infected through handling the carcase are given special medical attention.

IN THE BIRMINGHAM ABATTOIR

	Cattle killed	Cases of *C. bovis* found	Percentage
1950	68,265	322	.05
1957	47,465	487	1.02

Since the war the number of cases of *Cysticercus bovis* have increased, but fortunately very few are generalised. All the same, the condition must cause quite a loss to the butchers concerned, due to the depreciation in value as a result of the refrigeration to which the carcases have to be subjected. It is

possible that the tapeworm eggs are in many cases still viable after passing through the sewage works and may be deposited on pastures to be ingested by cattle (Silverman & Griffiths, 1955).

Trichinosis is now very rarely reported in humans in this country. It is generally considered that meat inspection is not the best way to safeguard human health in dealing with this condition, but rather to take steps to prevent the infestation of pigs and to make it known that pork and pork products should be well cooked. In Birmingham, however, we do regularly carry out microscopic examination on a small percentage of carcases of imported pork.

I cannot mention all the diseases met with in the abattoir, but before leaving the question of meat inspection there is one point which deserves serious consideration, as it has a definite bearing on public health. In my opinion it is undesirable to allow diseased meat, and offal which has been found unfit for consumption at slaughterhouses or comes from knackers' yards, to be sold in the raw state without proper control. It is often used for the feeding of pet animals and is purchased by the housewife. Some of this material is not even fit to handle, and when brought into the kitchen may contaminate human food. I doubt whether many people would allow their pets to eat this meat if they knew the origin of it. Occasionally even anthrax affected meat has found its way into pets' meat shops. Think of the danger that might result to human beings from the feeding of offal containing Echinococcus cysts to one's dog. In Birmingham we have a by-law prohibiting the sale of this class of meat for pets unless it is first sterilised.

Meat for Feeding Pet Animals

In December, 1953, the Ministry of Food issued instructions concerning the disposal of meat and other materials condemned as unfit for human consumption at slaughterhouses which were under their control. This material was only allowed to be sold under certain conditions. It had to be sterilised in some way, an exception being made, however, if it was to be used by establishments such as zoos and menageries. When sold, notification had to be given to the Medical Officer of Health of the district to which the raw meat was being taken, and the names and addresses of the consignees were required. Another condition was that the meat must be stained green before delivery. Unfortunately, when meat was decontrolled in July, 1954, this control on the disposal of condemned meat ceased. Evidently the Ministry of Food had realised up to this time that this meat constituted a danger to public health. The danger from it and from similar meat coming from knackers' yards, is still with us, and surely a regulation is needed on the lines of the circular issued by the Ministry of Food in 1953. In addition to the danger to health when sold raw for pets' food, this meat if allowed to get into wrong hands, might in some form or other be used as food for human consumption.

Brucellosis is the cause of a certain amount of human ill health, the extent of which is difficult to estimate, since it is not notifiable. The heat treatment of milk now generally carried out prevents many cases, and the use of vaccine Strain 19 has greatly reduced the number of infected cattle. Probably, after bovine tuberculosis has been eradicated, steps will be taken to eradicate this disease also.

Except in poultry, Salmonella infections are fortunately not common in our food animals. However, cases do occur sometimes, particularly in the emergency slaughter type of animals, and the veterinary officer working in the abattoir must always be on the look-out for them. Food poisoning types of Salmonella organisms have been found in samples of egg albumen and frozen whole egg imported into the country for use by the confectionery trade. There seems to be some difficulty at the moment in finding a satisfactory method of sterilising this product, but I understand there is a possibility this difficulty will be overcome.

Animal Disease Transmissible to Human Beings

There are a number of diseases in pet animals and birds which the veterinarian in practice may meet with, which may be transmitted to their owners. In such cases he is able to advise his clients on the precautions to be taken, and where there is evidence of human illness he will suggest that medical advice be sought.

Tuberculosis is occasionally found in dogs, cats and parrots, caused usually by the human type of the bacillus, although in cats, particularly, it might be due to the bovine types. In 1957 my medical officer asked all veterinary surgeons practising in the Birmingham area, to inform him when dogs or cats were suspected of having tuberculosis, or if the disease were found on *post-mortem* examinations of these animals. Laboratory assistance was made available. In such cases, he stated, the possibility of humans being involved would be investigated. Similarly where tuberculosis is diagnosed in human patients and pet animals may be involved, the owners are advised to call in their veterinary surgeons.

Leptospirosis, mainly affecting rats and mice, is another disease fairly commonly found in dogs and less frequently so in pigs and calves (Field & Sellers, 1950). It can be transmitted to man producing, in its most serious form, Weils disease. Cases have recorded (Broom, 1951) in slaughterhouse and agricultural workers, the causal organism—which is present in urine—gaining entrance through the skin. It appears that animals may harbour the infection without showing symptoms. The preventive measures to be taken include the extermination of rodents and the proper protection of cuts, scratches, etc. present on the hands of workers dealing with susceptible animals.

Psittacosis is another disease capable of transmission to man, but fortunately it is not now commonly seen in this country. I have only met with one case, in which the manager of a large pet shop died, and at about the same time a number of birds he had for sale also died due to this

disease. In all about 50 birds died out of a consignment of 200 from Australia. Soon afterwards the Psittacosis Order of 1953 was made which gave more powers to the officers concerned to deal with affected birds.

Other Duties of the Municipal Veterinary Officer

There are other duties which may be carried out by the municipal veterinary officer, some of them not directly connected with public health. For example, a veterinary certificate is required when certain meat and meat products are exported, and dogs and birds leaving the country need a health certificate. Packing straw and sacks used for the export of food to certain countries have to be disinfected under supervision, and have a certificate to satisfy the authorities abroad that foot-and-mouth disease infection will not be carried.

It is probable also that the veterinary officer will be responsible for giving veterinary service to any animals owned by his local authority. These may include police and draught horses, police dogs and, in addition, cattle, pigs and poultry at various institutions.

As an inspector under the Diseases of Animals Acts he has to enforce all Orders, report contraventions to his committee, and notifiable diseases to the Ministry Divisional Veterinary Officer. Possibly, also, he issues the necessary movement licences for animals.

Routine visits to pet animal shops, pig keepers' premises, cattle sidings and riding schools are required, to see that the conditions of licences are complied with, to look for contagious disease, and to help maintain the welfare of the animals.

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THE SPEAKER'S INTRODUCTION

Mr. C. G. Allen said that in his paper he had only been able to give a brief outline of the work undertaken by the Veterinary Department. It was appreciated that the work differed in different towns.

The most important work of his department was to protect the health of the public, first by a system of food inspection, and, second, by the prevention as far as possible of the transmission of disease from animals to man, transmission being possible in other ways than by the consumption of the various meat foods and milk.

It would be noticed that he made it clear in the paper that the municipal veterinary officers were not the only members of the profession who were engaged in public health work. The members of the State Veterinary Service and the veterinary practitioners in practice were carrying out what was probably the most important part of the work in the public health field, because they were working at the source from which the meat and milk supplies came.

There was a great example in the case of bovine tuberculosis of how those practitioners and officers of the state service had worked and were working actively to eradicate that disease. They were helping the farmer in other ways to produce healthy food animals which had the result of providing wholesome foods which were essential for the well-being of the people. It was doubtful whether the general public appreciated that work, particularly in the case of the eradication of tuberculosis. In the dairy farms and slaughterhouses a marked decrease in the incidence of the disease had been noted among the cattle, and that must also of course result in much less human suffering and less expenditure on maintaining sanatoria. It was mentioned in the paper that Birmingham Corporation started in a small way a private eradication scheme as far back as 1908.

Meat inspection was the most important part of the municipal veterinary officer's work. He not only dealt with fresh meat and meat products and milk, but also with the live animals when they came to the slaughterhouse. He looked after their welfare, and of course was always on the look out for contagious disease. He carried out *ante-mortem* inspection wherever possible. It used to be thought that centralised slaughtering was just around the corner, but it seemed still quite a way off. Many local authorities were unwilling or unable to offer sufficient remuneration to attract veterinary graduates to take on that work, and it was having a serious effect. The numbers were decreasing and because of that it was not possible to carry out the work as the profession would wish to carry it out. The Government could help to improve the service. A small grant was offered to local authorities to carry out a 100 per cent. inspection if they exported inspected meat to other authorities' areas; but only on that condition. In the author's view a further grant should be given to local authorities if they showed that they were trying to make a better job of meat inspection by having a veterinary service in their area to help with that work.

Veterinary officers did not want to carry out the whole of the inspection of meat. It was necessary to work in with, and have on the staffs, public health inspectors who did a fine job of work. But the more animals which were dealt with, the more problems and the more doubtful cases arose. He felt sure that those inspectors required that extra expert advice, particularly in borderline or doubtful cases. The majority, fortunately, were straightforward cases, but the more animals dealt with the more often did awkward cases arise and surely the owner was entitled to have his carcase of beef examined by experts when there was any possible doubt whether it should be passed or condemned? In present times the value of a carcase of beef was quite high. It was a much more serious problem financially to lose a whole carcase of beef than it used to be. On the other hand, the consumers surely expected their local authority to take all precautions to make sure that there was no doubt whatever as to the fitness of the meat they bought.

Those delegates who had, the day before, witnessed Mr. Olivant's demonstration of meat inspection technique must realise that the system employed in this country was far behind that of many other countries. It seemed so strange that the Government insisted on *ante-* and *post-mortem* veterinary inspection of meat coming into the country but there was no such standard required in the case of home-killed meat. The aim was at the moment to secure throughout the country 100 per cent. inspection, but such inspection was of no use unless it was absolutely efficient. Although it was simply repetition of what had been said many times before, efficient meat inspection required *ante-mortem* inspection and facilities for bacteriological examination in doubtful cases.

In the paper reference was made to the question of diseased meat and offal, either from slaughterhouses or knackers' yards, being sold in the raw state throughout the country for the feeding of pet animals, and being handled by people who had no idea of the dangerous nature of the meat. The point was made that during control the Ministry of Food realised that and had a regulation which dealt only with their own condemned meat from slaughterhouses. There was also a similar—possibly worse—type of meat from the knackers' yards, and it was felt that some regula-

tion applying to the whole country should be made to control that. If such meat had to be used, it should first of all be sterilised before being sold to the housewife.

The Openers

Dr. J. M. Ross, in opening the discussion, said that Mr. Allen in his excellent paper had painted the veterinary interests in public health on such a wide canvas that in the short time at his disposal he could only hope to elaborate a few of these.

The field of zoonoses, the term more commonly known in recent years, was the meeting ground of the two professions for the protection of the public health—the Association's from the veterinary point of view and his from the medical. After more than 20 years in public health he got the impression, indeed it amounted to more than an impression, that over the years the two had been coming closer and closer in a bond to the common weal. The major impulse to this might well be that the marked reduction in, and the changing pattern of, many of the diseases spread from man to man had brought into greater prominence and importace the spread of infection from animal to man.

This relationship of animal to human health had been aptly expressed by Middleton—"When man domesticated certain lower animals for his personal comfort and gain, he assumed the obvious hazard of sharing their diseases." They shared scores of diseases with animals, but fortunately many were rare in man. More fortunately still, many of those diseases transmissible from animal to man did not affect them in this country, but with the speed of modern travel this immunity might not always remain. Further, many of the diseases had been eliminated already, or were well on the way to elimination.

This might therefore be a convenient introduction to milk-borne disease. Reduced to basic principles the incidence of milk-borne disease was dependent on three factors:—

1. The amount of disease in dairy cattle.
2. The amount of disease in milk handlers.
3. The extent to which milk supplies were heat treated.

Therefore any measures tending to reduce or eliminate the first two of these factors and any increase in the third should reflect a diminution in human disease from milk. The change in the last 25 years had indeed been remarkable, and Mr. Allen gave pride of place to the eradication of tuberculosis from cattle for two reasons. First, because his Authority was one of the pioneers in this field; the second spoke for itself—the magnificent achievement of having within this short period, and a world war intervening, 76 per cent. of herds attested and the estimated fulfilment in 1961. Complementary to this there were specified areas amounting to 71 per cent. of the area of England and Wales embracing 93 per cent. of the population, and 92.3 per cent. of the milk was heat treated. With the combination of all these factors bovine tuberculosis in human beings from infected milk had virtually disappeared.

He would like, however, to take Mr. Allen up on one point where he said, "until this disease (tuberculosis) has been eradicated from our herds, milk should be pasteurised to make it safe." The implication here was that after 100 per cent. attestation pasteurisation could be dropped. He doubted if the speaker really meant this in view of the remarks he made later on, but if he did, Dr. Ross said he must disagree so long as there still remained other transmissible diseases.

As Mr. Allen further emphasised, another result of attestation was the marked reduction in tuberculosis found in animals slaughtered in the abattoirs.

But all this progress brought other problems in its train. It had always been assumed that bovine tuberculosis of man could be prevented by the heat treatment of milk, but in more recent years it had been shown that air-borne infection constituted an occupational risk to those working in infected cow sheds. Not only that but the condition was reversible.

Evidence had been accumulating over the years of herds freed from tuberculosis being reinfected by farm workers suffering from the bovine type of disease. Presumably, this was primarily a medical responsibility, but it must entail co-operative action. But what was the best way to tackle this? On the one hand did you simply include worker contacts in searching for the cause of breakdown in a herd, or did you consider some scheme for routine examination of all farm workers—which would have to be voluntary? Even with no idea of what the breakdown figures were likely to be the latter struck him as being somewhat too ambitious. Anyhow, he put this point to the meeting.

Dr. Ross then passed to two other diseases in this field which to his mind were of some importance to both professions. The first of these was brucellosis, which was reckoned to cause more illness, misery, and economic loss than any other. As Mr. Allen pointed out, the incidence of this disease in human beings was difficult to estimate. However, the evidence suggested that human brucellosis could seldom be attributed to the ingestion of milk now that so much milk was heat treated. Most of the cases (estimated at 80 per cent. in this country and 90 per cent in America) arose from contact with infected materials and these hazards were dependent on the presence of infection in animals.

Brucellosis as an urban disease had practically disappeared. At the same time there was the pointer to quite a number of cases—sub-clinical and chronic—in rural workers. Indeed, it might be emphasised that this disease, like many of the zoonoses, was often a silent infection in both man and beast. Progress was being made with vaccination of calves, and the hope was expressed that elimination in cattle might be the profession's next objective. But this goal was some way off. Meantime, was enough being done in the way of education in the rules of hygiene of farmers and farm workers handling animals? He might be wrong, but somehow he felt that this was a "No-man's-land" in public health.

The same question might be posed regarding his second disease, "Q" fever. The difference here was that the organism did not appear to give rise to any definite symptoms in the animal, but in humans it caused atypical pneumonia. To the veterinarian, therefore, this disease might be only of indirect interest, and eradication might be considered to be unjustifiably expensive.

Prevalence varied markedly in different parts of the country, and in some areas, *e.g.*, Kent, it was practically endemic. Cows, sheep and pigs were affected. Here again human cases seemed to arise mainly from inhalation of infected dust, as for instance in an outbreak affecting 28 students at the Canterbury School of Art, supposedly from infected straw. Most cases, however, were found in those working with animals, and on farms raw infected milk could not be ruled out. Some investigation was called for into the respective rôles of milk and air-borne infection; opportunities for transmission of the disease could then be cut down.

Members had heard at an earlier session how complex a subject was salmonellosis. The primary host was animal and practically all strains, given ideal conditions, were pathogenic to man. Fortunately, those ideal conditions were only seldom present.

Since 1949 Salmonella food poisoning had leaped into prominence, and over these years there had been a marked increase in the number of incidents reported. This increase, however, was partly true and partly apparent—the latter resulting from improved reporting and facilities of investigation. And, as Dr. Ross had explained the other day, food poisoning with Salmonella as the causal agent was notifiable, but not salmonellosis *per se*. Further, there was ample evidence that many cases of salmonellosis were cross infections and were not associated with food. At the beginning of this year the report forms were revised to allow for the reporting of cases of salmonellosis as an entity; the outcome might well prove interesting.

Dr. Stableforth, at an earlier session, had put forward a plea for concerted action to eliminate salmonellosis. The common aim must be to combat this infection and presumably the method of choice was the elimination of the disease in the host animal.

Meantime, this did not mean that they should adopt panic measures. As ways and means were found for eliminating the organism in food they would be adopted, *e.g.*, in egg products. They must remember that between black and white there were shades of grey, and to those shades of grey they applied their knowledge and experience in assessing the dangers to the public health. For the case was far from proven that the presence of Salmonellae in certain

foodstuffs was the origin of frank disease. In fixing their eyes on the goal they should not forget that their charge was the *greatest* good for the *greatest* number. If they did forget, they might endanger the economics of the food trades, and the physical welfare of the people.

Draft Regulations had, of course, been circulated on the Staining and Sterilisation of Unsound Meat. The danger to the public health from feeding such meat to animals was not quite so clear cut as Mr. Allen suggested. The problem really fell under two headings: (1) direct and (2) indirect.

Dr. Ross and his colleagues on the medical side could give full support to the first, for instance, the dangers from contamination of utensils, etc., or other foodstuffs. He would like to quote a recent case as an illustration. Some months ago a woman in Hull died from an illness due to *Salm. bredeney*. The organism was also isolated from a family contact and from the dog. Investigation revealed that the patient regularly bought meat for the dog from a knacker, and that sometime before the illness occurred she had cut up "horse meat" (which the seller said might have been condemned cow meat) on the kitchen table. It was not difficult to work out what had then happened.

The indirect dangers would lie generally within the field of animal health. The feeding of diseased meat to cats and dogs, for instance, might cause disease or a carrier condition in the animals which might then infect their owners or others. It could create or perpetuate reservoirs of infection in animals. On the medical side they might be able to help when disease in human beings was being investigated epidemiologically, but the principle, *i.e.*, the use of such meat for feeding to animals, was one for the veterinary surgeon to elaborate.

Mr. H. E. Bywater said that despite the realisation of the World Health Organisation and other bodies of the increasing importance of veterinary participation in the control of the so-called "zoonoses," the municipal veterinary services in England and Wales were totally inadequate, and, regrettably it must be faced, might well be described as "vestigial." It might be of use to remind some of the younger members that the present position had arisen from a variety of causes. The passing of horse transport (incidentally materially assisted by the invention of pneumatic tyres by the Belfast veterinary surgeon, Dunlop) closed a field of great municipal importance. More recently, the formation of the National Hospital Service and the taking over, and in many cases the relinquishing of farms formerly attached to local authorities' hospitals and institutions, also had its effect. The great depletion in local authority veterinary services, however, occurred at a time when they were most numerous and, indeed, were expanding, with the enlargement of the Animal Health Division of the Ministry of Agriculture and the consequent loss to municipalities of purely veterinary duties under the Diseases of Animals Act. Nationally, that expansion of the Ministry veterinary services was unquestionably beneficial, but locally in many cases it was very much otherwise.

The present veterinary staffs of local authorities were almost entirely founded upon meat inspection, and although the veterinarian could—and should—be employed in a much larger field of public health, there was a disinclination by local authorities and their officers to invoke the aid of the profession in wider spheres of activity. In present days, when local authority officers in many cases were apprehensive of a tendency for their duties to diminish rather than increase in scope, perhaps that was a natural reaction. The ever-increasing burden upon local finance was also a major deterrent. Progressive authorities, prior to the last war, endeavoured to provide the best local services possible. It would appear that most were now more concerned with economies and were content to adopt a less ambitious outlook.

With opportunities for fuller and more remunerative occupations in other branches of veterinary practice, the lack of opportunities for advancement and the low level of salaries in local authority service offered few inducements to members of the profession.

The veterinary services in Birmingham had always been noted for initiative, and it was gratifying that the author had drawn attention to the pioneer work in that city in connexion with tuberculosis infection of the milk supplies at a time when it was not uncommon to find 10 per cent. or more of the milk samples infected.

The contribution to public health which had resulted from the general improvement in milk production in that and other respects was apt to be overlooked in present days when pasteurisation was almost universal. Mr. Bywater pointed out, however, that the need for pasteurisation would not cease with the eradication of bovine tuberculosis. Dr. Ross would doubtless agree that if only to control infection from human sources it would continue to be a necessary public health measure, as Mr. Allen would agree, although some readers of his paper might form a different impression.

Whilst wishing to avoid criticism of meat inspection as it was carried out in some districts and the lack of it in others (his impression was that generally the standard had improved somewhat within recent times), Mr. Bywater felt that whereas the public health, in that respect, was probably better safeguarded than prior to the late war, he suggested that much meat was needlessly rejected due to doubt on the part of the inspector and lack of willingness to enlist help from those whose expert knowledge could and should be used in an advisory capacity. Meat traders were generally very unwilling to contest the judgment of the local inspector lest harmonious relationships were impaired. He believed that in many instances if some of the larger meat traders were to employ expert consultants to check rejections, economies might well be effected without detriment to the public interests.

Bovine tuberculosis was rapidly diminishing in its incidence, but greater skill and care than ever before was necessary in the judgment of affected carcases. His impression was that in some of the herds resistance to tuberculosis was diminishing and that the acute form was now more in evidence. With the progress of eradication a higher percentage of reactors was being sent for slaughter. Slavishly to adhere to the recommendations of Memo 3/Meat might well prove dangerous to the consumer in certain cases. Inspectors needed to be better acquainted with the characteristic signs of active and quiescent lesions. Small active lesions might be indicative of widespread infection with tubercle bacilli whereas extensive chronic and calcified lesions might be present in a carcase the flesh of which was free of organisms. Care must be taken, however, to ascertain that amongst such chronic lesions there were none which exhibited signs of acute activity. There was no doubt also that lesions, particularly in the lymph nodes of pigs, were frequently mistaken for tuberculosis when they were due to other organisms.

Mr. Bywater said that as the eradication of bovine tuberculosis proceeded towards its final phases, the Ministry of Agriculture would need to have a very close contact with knackers' yards, slaughterhouses, and meat inspectors in order that cases of bovine tuberculosis which would inevitably occur from time to time might be identified, and the necessary steps taken to trace the source of infection. That would not be so difficult in Scotland, but in England and Wales it was patent that there would need to be a drastic change. The question of human tuberculosis infection in animals was also another matter which would probably need investigation.

Mr. Bywater said he could not overcome the impression that occasionally the incidence of cysticercosis was recorded at too high a level. He left that too often a small piece of fat on the knife of the inspector, or some other structure, was mistakenly thought to be *Cysticercus bovis*. He was not at all sure that where a single well calcified cyst only was discovered, it might not be possible to excise it and release the carcase without subjecting it to refrigeration which very materially reduced the market value of the meat. It would be interesting to know whether the author had any experience of refrigeration of such carcases after shrouding in calico or plastic materials. Exporting countries protected normal carcases in such a manner before refrigeration and thus produced a more presentable product. Such methods were very gradually finding favour in this country. It was common practice to wrap poultry and legs of pork before subjecting them to deep freeze, and the practice might well be extended with advantage. From his own very limited experience with *Cysticercus bovis* carcases, Mr. Bywater felt that protective covering was well worth

while, and that it ensured a better article when offered for retail sale. He was forced to conclude that *Cysticercus bovis* infection of cattle was spread, in the main *via* the sewage works. The majority of cases seen presented only a single, or at the most two cysts unlike the massive infestation which occurred in countries where direct contamination of pastures from human faeces was common. He recalled seeing such a case where, literally, one could not put a pin between the lesions in the carcase musculature. There was, he submitted, sufficient evidence to justify the conclusion that, with the widespread use of detergents and their effect on the surface tension of liquids, coupled with the excessive overloading of most of the sewage works, that condition, as it was seen, was due to the inability of the sewage system to deal with the problem.

He agreed with Mr. Allen in all he had to say about the undesirability of releasing uncooked diseased meat for pet animal feeding and, in passing, congratulated Birmingham for being the first to obtain Parliamentary powers in that connexion. He was somewhat doubtful, however, of the much publicised alleged harmful effects which might arise from the sale of imported frozen livers containing echinococcus cysts. He doubted whether the scoleces would be viable after freezing and the time lapse which followed.

Mention was made of certain diseases of pet and other animals which might be a hazard to public health. There was no doubt that a wide field existed there for co-operation between the medical and veterinary professions which, as yet, had not been opened up. Veterinary surgeons, both in public and private practice, could do much to assist if only the medical profession encouraged such help.

The duties of a municipal veterinary officer might vary considerably according to the locality in which he served. If he were in a district where there was a sea or air port and acted as the inspector under the Diseases of Animals Act, then he would be required to enforce the provisions of that Act, and the numerous Orders applicable to imports and exports. Such duties would include measures to be taken when prohibited animals or materials were brought into the port. Information of such infringements would be supplied mainly through H.M. Custom officials with whom, and the port police, he would need to work in close co-operation. Masters of certain foreign ships were apt very occasionally to bring live animals into the port as ship's stores, contrary to the Animals (Importation) Orders. Dogs and cats, if brought into a sea port from abroad, must be confined on board and not allowed to stray on the dockside or to escape. Difficulty not infrequently occurs in the case of cats whose numerical strength was liable to fluctuate!

Since it might be necessary to institute legal proceedings against offending masters of ships which might be in port for only a very limited period, his local authority had authorised their veterinary officer and/or town clerk to take proceedings without seeking prior authority from the Diseases of Animals Committee, and the use of such powers had been successful on several occasions.

The General Discussion

Dr. A. W. Stableforth (Ministry of Agriculture, Weybridge): "I have been asked to attend this meeting on behalf of the World Health Organisation and to say something about their activities in the field of veterinary public health which they defined in the report of their advisory group on this subject (1956) 'as the field of activity which protects and advances human well-being by utilising the combined knowledge and resources of all those concerned with human and animal health and their inter-relationships.' In order to attain this end, it is essential to co-ordinate the work and resources of all those agencies, official or private, which deal with coinciding interests of human and animal health. The view has been taken by WHO that to obtain the optimum contribution of veterinarians to human health it is necessary to develop a department of public health which contains medical men, veterinarians, epidemiologists, ecologists and microbiologists, together with part-time or occasional assistance from wider fields, such as those of animal husbandry and climatology. In many countries this is a new step which may not appreciably affect the veterinary administration principally concerned with control of disease in livestock, and it is not envisaged of course that such departments should deal with purely veterinary problems or interfere in any way with long established and effective governmental institutions.

"In such public health units it has always been policy that all concerned should have equal status (they may in fact take the same training as, *e.g.*, the M.P.H. (Master of Public Health) in the U.S.A.) and it follows from this that the head of such a department may be drawn from any of its component fields. The putting into effect of this policy has had some interesting results, for example, the present Head of the Communicable Diseases Division of the Pan-American Sanitary Bureau is a veterinarian, who was previously in charge of the zoonoses section of that Division. In Canada also, veterinarians have in at least two instances become rural health officers, their training in epidemiology being fitting and particularly well suited for this sort of work.

"The equal status given to all members of the Public Health Department, has, in certain countries, also had the result of making it necessary to raise the status of officers in the purely veterinary or other non-medical administration. This is an important point in many countries, particularly the less developed countries where the status and salary of the veterinarians may be insufficient to attract men of the requisite calibre to get effective disease control. In many of the older and more developed countries, the zoonoses have largely been controlled or eradicated by existing and different set-ups than those envisaged above. It is particularly in the now-developing countries that the development of a public health unit can have such beneficial effects in public health.

"*Zoonoses*: Over 100 diseases or infections which are naturally transmissible between animals and man are now known and a dozen to 20 can be considered to be of major importance in one country or another, for example, bovine tuberculosis, rabies, brucellosis, hydatidosis, leptospirosis, salmonellosis, anthrax, mosquito or tick-borne encephalitides (the so-called Arbor diseases), cutaneous and visceral larva migrans, the dermatomycosis, toxoplasmosis, and a variety of parasitic infestations. These have been the subject of two meetings of the Joint WHO/FAO Expert Committee on Zoonoses, the first held in Geneva in 1950, the second this year in Stockholm, and a seminar held in Vienna in 1952; together with a variety of special meetings, such as those of the Expert Committees on Rabies and on Brucellosis and the Study Group on Leptospirosis.

"The WHO/FAO Expert Committee on *Rabies*, held meetings in 1950 in Geneva and 1953 in Rome and training courses in India in 1952, in Africa in 1955, and South America in 1957, the subjects of discussion and courses covering mainly diagnosis and prophylactic measures.

"The FAO/WHO Expert Committee on *Brucellosis* held meetings in Washington (1950), Florence (1952) and Lima (1957) to appraise recent advances, whilst training courses were organised in South America in 1957, and Africa in 1958. They have also been responsible with FAO for the setting up of FAO/WHO Centres for research, diagnosis, and training in various parts of the world, as well as for supporting programmes to find vaccines for goats and sheep in countries where the disease is serious in these animals and their human contacts.

"*Leptospirosis* was the subject of a meeting in Amsterdam in 1955 and leptospirosis centres were designated in certain countries; to be supplied with internationally accepted type strains and to carry out collaborative research on epidemiology and diagnostic methods.

"*Food Hygiene*: A Unicef/WHO Group on Milk and Milk Products held a training course in Rome in 1953, arranged surveys in Yugoslavia and Japan in 1954 and continued their work on milk hygiene and utilisation through 1955. In 1956, the first FAO/WHO Expert Committee on Milk Hygiene was held in Geneva with Unicef. WHO sent consultants on meat hygiene to a number of countries in 1953 and organised a WHO seminar on meat hygiene in Copenhagen in 1954. A WHO/FAO Expert Committee on meat hygiene also met in 1954, and training courses on laboratory aspects of meat hygiene were held in the Eastern Mediterranean in 1955, whilst consultants on the same subjects were sent to Iran in that year. Collaboration with

FAO on milk and meat hygiene continued in 1957, a monograph on meat hygiene being published, as well as one on rural abbatoirs.

"*Future work* includes studies on the relation of influenza in man and animals, and on the general problem of emerging zoonoses, with a projected work on serological epidemiology. In addition plans have been made to study epidemiological approaches in comparative medicine (human and veterinary) to such problems as the cardio-vascular and degenerative diseases, and cancer. Radio-biology as it affects food contamination or food sterilisation is also to be given increased attention. The intention is to use the epidemiological approaches in comparative medicine on an international scale in co-ordinated researches where different local customs and environmental conditions and variables apply."

Councillor W. H. Russell (Glasgow): "I trust it will not be taken as an impertinence on my part coming to this rostrum this morning representing, as I do, a local authority.

"I was very much intrigued by the title of the paper so ably submitted by Mr. Allen. It seems to me that the impact of the veterinary surgeon's work is too much taken for granted, and not enough publicity is given to the work performed by him 365 days of the year in the protection of the public from such things as food poisoning.

"I am deeply interested in this question of tuberculosis in cattle and the fact that it is reaching the point of complete eradication, but what does the public know of this great achievement and the part your members have played in its fulfilment? In our area recently we had a special campaign against TB for the same purpose in regard to the human population and tremendous publicity was given to it by the Press; the results will be reported shortly and I believe they will be startling!

"I think local authorities have a measure of responsibility to give more consideration to the work of the veterinary surgeon's side, and your own organisation should likewise do something about the question.

"In these days of pushing wares that give 'lightness and brightness' there is no reason why a publicity expert should not publicise the veterinary surgeon's rightful place in a municipality."

Mr. G. V. Short (Wilmslow): "The fly-proofing regulations for abattoirs are to prevent flies infecting meat. Yet no such safeguards apply to *post-mortem* examination rooms to prevent the meat from infecting flies. In the first case the flies are possibly vectors, but in the second case they almost certainly are after contact with carcases and organs that would not be there unless suspect.

"The public health importance of bovine mastitis has 2 main aspects: (i) the antigenic properties of antibiotic residues in bulk milk, and (ii) the emergence of antibiotic-resistant mastitis bacteria. The first may cause antibiotic hypersensitivity in man, with grave sequelae to the medical use of the antibiotic later; the problem is essentially one that could be solved only by a rational use of intramammary antibiotic treatment of mastitis. The second aspect is aggravated by the danger to human health of antibiotic-resistant staphylococci, particularly those of phage-group III. Wallmark and Thörne in Sweden have recently shown that of 33 resistant staphylococci strains from 165 cows in 56 herds, 31 were of phage-group III, in which the majority of enterotoxin-producing staphylococci were included. These enterotoxins were not inactivated by pasteurisation."

Mr. C. V. Dayus (New Zealand Agriculture Branch, London): "In view of the shortness of time, I wish to mention one matter only. Reference has been made to the importation of reject livers. As far as New Zealand was concerned the livers were rejects carrying no certification. The product was exported in good faith for commercial purposes only, and one was under the impression that adequate control was possible at this end to ensure direction to proper processing plants. This proved not to be the case and in view of the circumstances, and to safeguard our own interests, the New Zealand Government has prohibited the export of reject livers as from August 31st last.

"In certain extensive grazing areas in the southern hemisphere with large sheep populations, dogs are required in numbers, and thus hydatidosis often becomes a problem. This has lead in New Zealand to the establishment of a new research unit and the provision of £150,000 to enable research to be intensified. I feel sure there will be collaboration between this research unit, representing both the medical and the veterinary professions, and the special Zoonosis Committee of WHO which was mentioned by Dr. Stableforth."

The Replies

Dr. Ross, in reply, said that as Mr. Dayus had explained, reject livers were since August 31st no longer to be exported from New Zealand. These livers had been imported into this country marked "For animal consumption only." The next thing that happened was a flood of protests from Medical Officers of Health that the livers were being displayed in butchers' shops for animal food; there was also the suggestion that some might even be consumed by the public. He had checked that there was little possibility of the scolices being alive, but that was not really the point at issue. It was felt that the principle was quite wrong that unfit food should be displayed for sale in this way.

As regards finding cysticercosis in cattle fed on pasture near the railway, it would be a mistake to jump to the conclusion that the infection originated from the permanent way. The sources of this infection were puzzling. His Department had been considering ways and means of enquiring into the condition from the point of view of, firstly, incidence, because this varied considerably in different parts of the country and over periods of time in the same locality, and secondly, source of infection particularly in "home" reared animals.

The disposal of sewage was outside his field, but he did know that a working party or committee was examining the conditions relating to seaside towns.

With regard to bovine mastitis and the use of antibiotics, this was a vast subject and in any reply could only be lightly touched on in a session of this nature. A great deal of work had been done in the United States resulting finally in a maximum dose for injection being laid down and the prohibition of sale of milk from infected udders for 72 hours after the last treatment. In this country Berridge of the National Institute for Research in Dairying had carried out similar investigations of milk going to processors. It was quite obvious that a certain amount of milk containing penicillin was being sold to the general public. In more recent months an article had been published in one of the medical journals giving details of three cases where the illness was allegedly due to penicillin in the milk consumed by patients. It might be that the presence of penicillin in milk was also having repercussions in food poisoning because there were a series of outbreaks due to staphylococcus toxin in dried milk in the summer months of 1954. The whole position was being investigated with a view to solution of the problem.

Mr. Allen, in reply, said he did not intend to convey the impression that milk should not be pasteurised after tuberculosis had been eradicated. He believed that it should still be pasteurised because of the other conditions which might be there.

He had not come across Q fever. So far as salmonellosis was concerned, all the cases of food poisoning in Birmingham had been due to food handlers. The meat could not altogether be blamed for that.

There had been trouble with egg products, and it was gratifying to hear that there was a possibility of making them safe in both albumen and liquid eggs. A great deal depended on hygiene starting in the slaughterhouse, because foecal matter might contaminate meat products.

So far as *Cysticercus bovis* was concerned, it must not be forgotten that it might not be the farm people themselves. Store cattle moved about and the real trouble lay quite a long way off.

He did not like the word "vestigial" when talking of municipal services. There was still a trace but what there was was useless!

He was grateful for the differentiation between active and chronic cases of lesions. It was necessary to avoid passing anything that would carry a disease. He still held to that. There must be no relaxation and as much severity as th[illegible] had been in the past.

As to the question of the calcified cyst, he understood that calcification started in the outer layer and it might appear to be calcified and yet be viral. Some cases which appeared to be calcified were not in fact dead. On the question of one single cyst, how could anyone be sure that there was only one cyst?

There was a firm which dealt in sausage casings and which was now producing large polythene bags which would envelope quarters of beef. That might lessen dehydration and produce a better article for refrigeration.

With reference to imported frozen livers, they were not wanted. There were enough in the country already, and they should not be in butchers' shops. In Birmingham if a butcher had a tray of meat marked for the consumption of dogs and cats, he broke a by-law in selling it in a raw state. Any meat sold for pets must be cooked before being sold.

He agreed with Mr. Thornton that animals which had died a natural death should not be allowed into slaughterhouses and dressed. It was turning the slaughterhouse into a knacker's yard.

It was interesting to hear of individuals not being granted a knacker's licence unless cooking apparatus was installed. The point was could they be made to use that apparatus? Some regulation was needed to control meat that was unfit for human consumption. It should not be allowed to be sold freely throughout the country.

He was grateful to Councillor Russell for his remarks.

Mr. Van Gils was right in saying it was not possible to get sufficient veterinary surgeons to take up the work of meat inspection, but it was not the schools which were to blame. If local authorities would provide more work he felt sure that there would be enough veterinary graduates to take it up.

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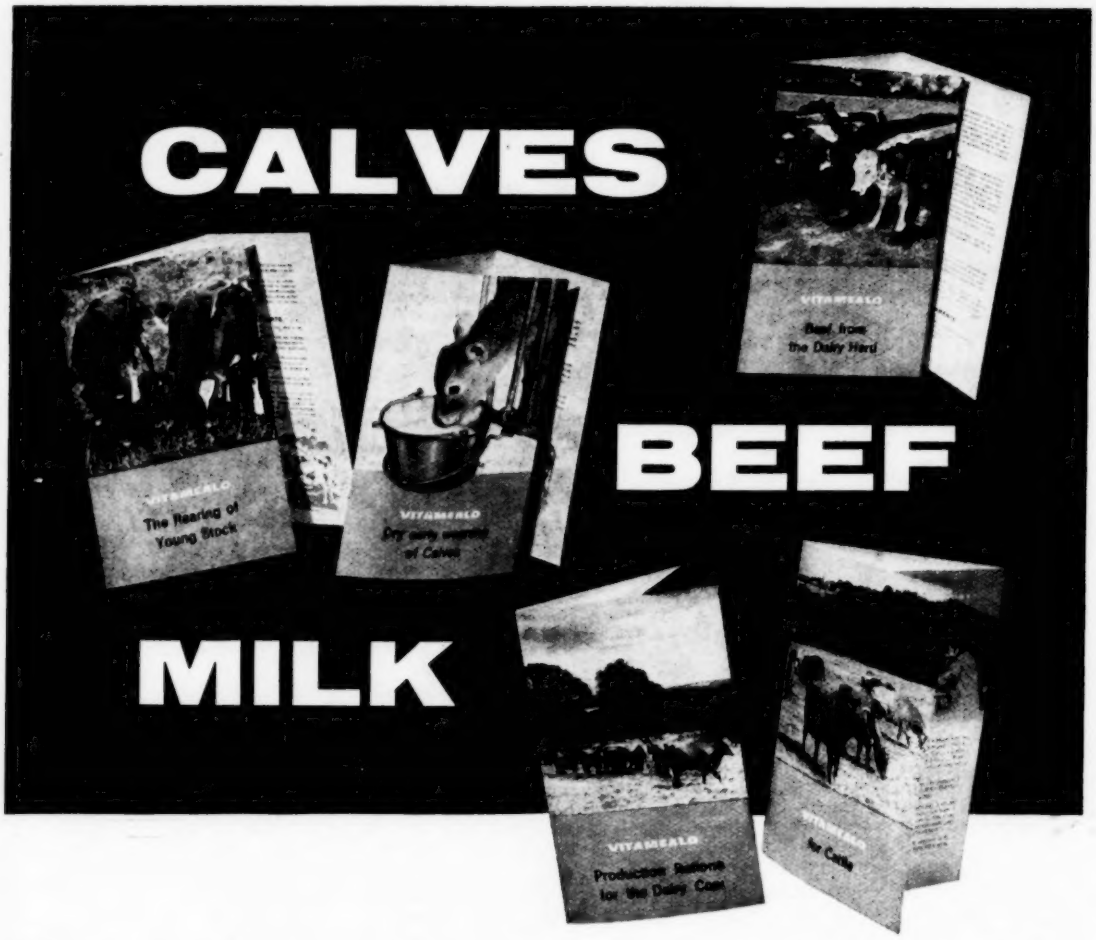

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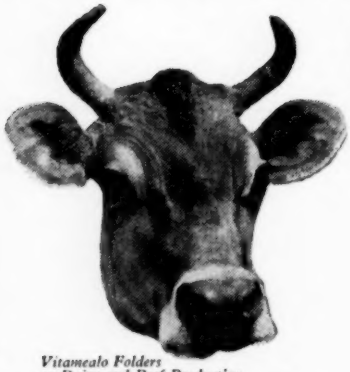

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The Global Picture of Animal Disease

BY

SIR THOMAS DALLING

Animal Production Branch, Food and Agriculture Organisation of the United Nations, Rome

DOMESTICATED animals are maintained for definite purposes—to provide specific foods and material for the use of man, to assist man in producing foods of vegetable or agricultural origin by supplying fertiliser for the soil and, in some parts of the world, labour for cultivating the soil, for haulage and transport work, to assist man in his sporting activities and as man's companions; in addition, animals sometimes represent the wealth and social standing of an individual or a community and they are concerned, often to a marked degree, with local, national and international trade. Different species of animals are used for the different purposes and, generally speaking, breeding of the species is designed to produce animals best suited for the required objectives. Throughout the ages there is evidence of alteration in type within the species, sometimes arising from popular opinion, sometimes from climatic conditions, sometimes from the need for adjustment to prevailing supplies and types of animal feeding, but more often to meet the human requirements for which animals are kept.

The health of animals has always caused some concern for it is amply realised that, although animals may recover from a disease, their maximum utility may be impaired, representing a loss, economic or otherwise. Animal production, referring to animals from which food for human consumption is derived, has been the subject of intensive study in many countries and, to-day, great efforts are being made to make improvements so that the essential products of animal origin, now in ever-increasing demand for human use, may become more plentiful. The three main methods being adopted for such improvement are improvement in health with control of diseases, better nutrition with all that is implied in the raising of crops for animal use and the breeding of animals most suited to the requirements demanded of them. While all three methods are important, each playing its part in arriving at the objective, stress must be laid on animal health and disease prevention and control so that the maximum results may eventually accrue from the combined effort. Improvements in animal health means that more animals will be available for specific purposes: concurrently, the provision of improved nutrition and of more suitable animals can take place. With improved health the same results may be obtained from a smaller number of animals and so, land needed to provide food for the larger number is reduced and can be used for provision of suitable cereal and other foods which, in some parts, are in short supply for human use.

This paper will not deal with details of animal diseases but in it an attempt will be made to show the general, over-all picture of animal diseases and their control throughout the world and the part played and to be played by veterinarians in the problems. It is, of course, impossible to deal with more than a few diseases in a communication of this length.

Epizootics

Rapidly spreading diseases of animals, causing deaths or loss of production are gradually being brought under better control throughout the world. There are, however, several diseases in this category which are still enzootic in some regions and, periodically, assume epizootic characters. Most are caused by viruses and thanks to the intensive study of viruses and diseases for the occurrence of which, they are responsible, control measures have been improved and are being applied. Into this category come diseases such as rinderpest, foot-and-mouth disease, Newcastle disease of poultry, swine fever, contagious bovine pleuropneumonia and pox diseases. They vary in their present distribution throughout the world, in some instances, their non-existence being due to the application of strict measures by governments through their veterinary authorities for the prevention of their introduction into a country or region.

Rinderpest

Rinderpest has never appeared in some parts of the world; in others it has been eradicated. It still exists, however, in some parts of Africa and Asia as an enzootic disease which, periodically, assumes epizootic characters. Rinderpest was finally eradicated from Great Britain in 1877 and Western Europe has been free for many years except for some infection introduced during the 1914-1918 war when Poland was invaded, the infection persisting for a few years only, and the occurrence of the disease in Belgium in 1920 following the landing of a consignment of zebu cattle from India consigned to Brazil. The active, efficient action of the veterinary authorities prevented spread of the disease and rapidly eradicated the infection although over 200 premises were involved. Vaccination against rinderpest is now being practised to a marked extent in countries in which the disease is enzootic. Since vaccination was introduced for the control of rinderpest the types of vaccines used have undergone marked changes, full advantage being taken in advances in research work on immunisation generally and on discoveries of treating and preparing biological products. To-day, the most commonly used vaccines are living rinderpest viruses, attenuated by passage through animals less susceptible than bovines, by passage and cultivation in the developing chick embryo or a combination of these techniques. The degree of attenuation of the virus for vaccine production varies with the susceptibility of

the breeds of bovines to be vaccinated : thus, there are available now goat-adapted, rabbit-adapted, avianised and lapinised-avianised virus-vaccines, so that even the most highly susceptible cattle and buffaloes can undergo vaccination, without the development of undesirable reactions, and rendered in a highly immune state. Such virus-vaccines can be lyophilised (freeze-dried) and so can be preserved for long periods when kept under satisfactory conditions. Large vaccination campaigns are either in progress or are now being planned. Thus, in India, extensive vaccination on a national scale is in progress, large areas of the sub-continent having already been covered. With the assistance of international organisations interested in animal health national and international plans are being discussed in the different infected parts of the world. It may be difficult, finally to eradicate rinderpest from all regions, especially when wild ruminants are involved and act as reservoirs, carriers and disseminators of the infection. By well-planned and, if necessary, intensive systematic vaccination, however, rinderpest in bovines can be satisfactorily controlled : veterinary services have now the means at their disposal.

Foot-and-Mouth Disease

Foot-and-mouth disease is widespread throughout the world : again, some regions, *e.g.* Central American countries have never been infected, while others have suffered only one (Canada) or a few (United States of America) periodical outbreaks which have been efficiently eradicated by active, early, veterinary interference. In many countries, especially in some parts of Africa and Asia, the symptoms and lesions are slight and, on the whole, the disease does not cause much local concern. From time to time, however, even in these regions, foot-and-mouth becomes an acute, rapidly spreading disease, causing deaths, especially in young animals and marked loss in production : nor must we forget the sequels which may follow even apparently mild symptoms, such as affections of the heart, leading to impaired working capacity and, often, sudden deaths. Foot-and-mouth disease and its control are complicated by the occurrence of so many distinctly independent types of the causal virus which appear to be immunologically distinct. Thanks to the careful research work carried out by veterinarians, especially in our own country, seven district types of the virus have already been demonstrated : it may be that other types exist—time will tell. Again, within some of the recognised types, there appear to be distinct sub-types, with at least some antigenic differences. The whole subject of types of foot-and-mouth disease virus is complicated. It has for long been recognised that intensive work on a large scale in well-equipped institutes was necessary to clear our knowledge on types and sub-types and to study the epizootology of foot-and-mouth disease on a world-wide scale. We are happy to know that the Research Institute, Pirbright, has recently been designated the Foot-and-Mouth Reference Laboratory for much of the world. From the activities of this Institute together with those of other parts of the world, especially those in Brazil (Pan American Sanitary Bureau) and on Plum Island (United States of America), we may expect to have much more information on these complex subjects.

The control of foot-and-mouth disease receives active consideration in many parts of the world and, even in countries in which, formerly, little attention was given to the presence of the infection, steps are now being discussed for its control. It is admitted in all quarters that a slaughter policy as carried out in this country is the ideal and most satisfactory method of dealing with outbreaks of foot-and-mouth disease. Such a policy is applicable to and is operated by some countries in which the disease is not enzootic, in which there is a full understanding of the necessary implications of such a policy and where full collaboration with the veterinary service of all concerned can be assured; furthermore, it is admitted, generally, that the application of any other means for the control of foot-and-mouth disease should be so enacted that, ultimately, the incidence of the disease in a country will be reduced to a state when a slaughter or stamping-out policy would become possible. The conditions necessary for the practice of a slaughter policy are difficult to fulfil and, unless they are agreed and faithfully applied, such a policy cannot be expected to succeed. It will be remembered that in connexion with the recent extensive outbreaks in Mexico a slaughter policy had eventually to be abandoned in favour of vaccination.

Foot-and-mouth disease is being controlled to-day in a number of countries by vaccination of susceptible animals, mostly bovines. The policy varies from systematic, periodical vaccination of the entire cattle population with slaughter of infected and potentially infected animals as in Holland, to the vaccination of cattle in areas or zones surrounding outbreaks combined with the slaughter of infected and contact animals in infected herds, as in Denmark, or the vaccination in zones surrounding outbreaks without any slaughter as in some parts of Germany, or vaccination along frontiers with other countries from which the infection may spread as in Yugoslavia. There is no doubt, whatsoever, about the value of vaccination when systematically applied in the control of foot-and-mouth disease. Any country in which an out-and-out slaughter policy, with all its implications, can be applied and maintained should not be tempted, even under apparently difficult conditions of spread within the country, to depart from such a policy.

The introduction of vaccination against foot-and-mouth disease has certainly placed a valuable weapon in the hands of veterinary services. Vaccine, prepared by either the original method in which the live animal is used for the production of the necessary virus or virus is obtained by cultivation on living tissues, are now becoming more and more available; international organisations are encouraging their production and use and are supplying financial and technical assistance for their support. Such organisations are also concerning themselves with the maintenance of freedom from the infection in countries and groups of countries now free, *e.g.*

in Central America, with collaborative effort to control and eradicate the disease from areas, *e.g.* the work of the European Commission for the Control of Foot-and-Mouth Disease, and are studying ways and means of preventing the transmission of the infection through the medium of infected meat and meat products. Bold decisions, efforts and action are called for: all revolve around international collaboration and efficient veterinary services.

Newcastle Disease

Newcastle disease in poultry, while still widespread and causing heavy economic loss in some parts of the world, is now capable of being controlled to a large extent. The disease in its acute form is readily recognised and, because of the high mortality following its appearance in a flock or area, causes some degree of self-limitation, unless general measures for the prevention of spread are absent. Once the highly infectious nature of the disease is recognised in a country in which the acute disease is present, its spread will usually become limited. On the other hand, the difficulties in recognising the milder type of the disease, for which laboratory tests are often necessary, with the low death rate, so complicates the picture that the existence of such an infectious condition with its resultant economic loss, may fail to attract the attention which it deserves and which is needed for its control. Once again, for control and prevention of spread, the operation of a slaughter policy as operated in some countries including this country, would be expected, eventually, to yield the most satisfactory results. It can be appreciated, however, that, especially where the disease is widespread and where veterinary services have not yet reached a high state of development, such measures are impracticable. Vaccination is the method of choice in the absence of a slaughter policy and is now being widely practised. Vaccines in the wet or dried state, consisting mostly of virus attenuated and cultivated in the developing chick embryo, are in general use in many countries. The strains of virus used for such vaccines vary with the requirements of the vaccine and the susceptibility of fowls of different ages. The need for the choice of the most suitable types of vaccines and for their systematic application according to a recognised and agreed plan must be emphasised, for haphazard use of vaccines may not only fail to give anticipated results but may even effect considerable damage and loss among treated stock. The use of a naturally attenuated virus in very young chicks, for example, has been followed by the production of immunity of high order and has gone a long way in improving the poultry industry in some parts of South-East Asia; the immunity so produced, however, has to be reinforced at a later stage. It is of some interest, also, to note that this virus-vaccine may be used simultaneously on very young chicks with a vaccine produced from a strain of fowl pox virus, so rendering such young birds immune to both Newcastle disease and fowl pox, at least for a period. It can be stated with all assurance that vaccination against Newcastle disease has made possible the development of a poultry industry in parts of the world where severe handicaps were being experienced and that the control of the disease has resulted in greatly increased supplies of animal protein in the form of eggs and poultry meat, so badly needed in some of the countries concerned.

Swine Fever

Swine fever continues to be a cause of economic loss in many parts of the world. While the strict application of measures to prevent the entrance of the infection into a country has resulted in complete freedom from the disease, *e.g.* in Denmark, occasionally they break down, often due to causes outside veterinary control and introduction takes place. Recent examples are the appearance of the disease in Australia, on an extremely limited scale during World War II, associated with food products brought into the country for the use of military personnel from other parts of the world and the more recent occurrence of the disease in the Republic of Ireland which had been free for many years. At one time it was universally accepted that there existed a single immunogenic type of or strain of the causal virus, varying in virulence and its pathogenic effects according to conditions. It has been shown, however, that different types exist throughout the world. In parts of Africa, for example, there is complete evidence of marked differences in the virus causing swine fever than that found in European and American countries: and differences were found in strains recovered in Canada from those prevalent in the United States, an observation which led to the discovery of antigenic differences in some American strains, which probably accounted for some of the failures in immunisation practised in that country.

Methods of control of swine fever differ throughout the world; vaccination, however, occupies a prominent place in some parts. It is not always easy to make an accurate diagnosis of the disease in the absence of typical symptoms and lesions; new laboratory techniques, now the subject of experiment, hold out some hopes that difficulties may be overcome. It is also interesting to note that more recently introduced methods are finding a place in the control and prevention of the disease. Although the simultaneous injection of live virus and hyperimmune serum has been practised for many years in some parts of the world, the method is being replaced by the use of vaccines the preparation of which has been evolved from the results of scientific research on general biological problems. Thus, there is now available virus contained in the blood and other tissues of artificially infected pigs, treated chemically and by heat (*e.g.* crystal violet vaccine) and live virus obtained by passage through rabbits and used either alone or simultaneously with hyperimmune serum. In spite of some disadvantages following the use of such types of vaccine, which undoubtedly will be overcome with further study, vaccination is controlling swine fever in many parts of the world.

Contagious Bovine Pleuropneumonia

By the adoption of veterinary and other measures,

sometimes drastic, contagious bovine pleuropneumonia was successfully eradicated from extensive areas throughout the world, including the continent of Europe and the United States of America. The disease continues to persist, however, in parts of Africa, India and Australia. Many difficulties have arisen in controlling the disease in these parts, concerned largely with the movement of cattle. The imposition of quarantine measures does not always prevent the spread of infection. Because of the existence of carriers of residual infection in the lungs, it may not be possible to effect a clinical diagnosis during life in some animals which may act as spreaders of the causal agent. Considerable attention has been given to diagnosis and vaccination. The methods practised for many years yield comparatively satisfactory results; more recent study, however, appears to indicate improvements which might yield even better results and there is now need for some large-scale experiments to compare different techniques and methods with a view to obtain definite evidence of the practicability, usefulness, safety and financial considerations of them.

"Pox Diseases"

Among "pox diseases," fowl pox is the most prevalent, occurring in practically all countries where poultry are kept, even on a small scale. The infection is being controlled by vaccination, either pigeon-pox or fowl-pox virus being used; immunity of long duration follows successful vaccination with fowl-pox virus, which is now cultivated on the membranes of developing chick embryos and can be dried, kept under suitable conditions for long periods and reconstituted when required for use. As with all biological products, careful selection of the strains of virus for vaccine production is necessary : in this respect, attention has already been drawn to the strain found in a naturally attenuated condition in this country and used successfully for the vaccination of very young chicks.

Of the other "pox diseases," sheep and goat pox are those most commonly found, the infections being prevalent in most of the Near-East countries in which heavy losses might occur among infected animals. The antigenic relationship between sheep pox and goat pox has been a subject of much discussion. Strains of the infecting viruses appear to differ in their infective power but it is now recognised that there seems to be no antigenic differences between some strains for sheep or goats, the difference being one of host range, some strains of sheep-pox virus being practically non-infective for the goat while some strains of goat virus, by intradermal inoculation, produce reactions equal in severity to those produced in the goat. Using some strains of the two viruses, cross protection seem to be complete when a reaction follows the original inoculation.

Zoonoses

The term "zoonosis" is now commonly used with reference to diseases which infect animals and are transmitted from animals to human beings. The list of such disease is long and some may be of little importance in so far as the human subject is concerned. In this section of this paper we will consider only tuberculosis, brucellosis, salmonellosis, rabies and swine erysipelas.

Tuberculosis

There is little need to discuss tuberculosis in animals at a meeting such as this, composed largely of British veterinarians, except to point out that tuberculous infection varies considerably in incidence in animals in different parts of the world, largely according to the methods of husbandry practised and the production demanded. There is little doubt that bovine and avian tuberculosis have been spread in some countries by the introduction of cattle and poultry, from infected parts, presumably with the object of improving breeds and their utility : such occurrences have taken place during recent times in spite of the application of diagnostic tests and other precautions. Tuberculous infection in countries in which the incidence is low may not be observed until animals are slaughtered for human food : again, such diagnoses may be made only if careful inspections are carried out. In collecting information on the incidence of tuberculosis throughout the world, one has been struck with reports of an incidence in dogs, greater than one might have been led to expect. Rapid strides have been made in the control and eradication of tuberculosis in all countries in which measures have been and are being applied. Some countries and areas have been completely freed, in others the end is in sight. There is no better example of rapid results than in Great Britain where the use and interpretation of the tuberculin test is the basic consideration; we are following this rapid progress with much interest and look forward in the comparatively near future when it can be asserted that bovine tuberculosis is practically non-existent throughout the country. It is now generally agreed that any eradication scheme for tuberculosis must be based on tuberculin testing, in spite of certain drawbacks and difficulties, most of which can be overcome. As is well known, experiments with vaccines composed of tubercle bacilli, sometimes in a living attenuated form were carried out in cattle and hopes were raised that the creation of an immunity or resistence to tuberculous infection might become a practical procedure : most noteworthy was the B.C.G. vaccine. It is now recognised that the difficulties and complications inherent in such vaccination do not warrant the use of such vaccines and the method has been abandoned. Although it is sometimes suggested that vaccination might be a preliminary method of control, especially in lesser developed countries, even there it cannot be recommended.

Brucellosis

There are few countries which can claim freedom from brucellosis, although its incidence varies throughout the world, again being dependent largely on the type of animal husbandry practised and the production demanded. As with tuberculosis, the incidence of brucellosis has sometimes been increased or Brucella infection has actually been introduced into some countries by the importation of livestock. Instances can be given, for example, of the introduc-

tion of *Br. suis* infection by such means. While methods for the control of *Br. abortus* infections are now available and the incidence of the infection is being reduced as a result of their practice, especially the application of recognised diagnostic tests and the use of attenuated vaccines, the position regarding *Br. melitensis* and *Br. suis* infections have not yet progressed to such a stage. *Br. melitensis* infection still prevails in some countries. It has now been recognised that diagnostic tests are valuable from a flock point of view but that the results cannot be applied, with confidence, to individual animals. Intense research work, involving the use of goats and sheep on a limited scale has been and is still in progress, both individual countries and international organisations taking part. A stage has been reached when many details of the antigenic structure of the causal agent have become available, values can be placed on the different diagnosis tests and biological products of different types, produced from the causal agent. It will be necessary to examine the value of such products by large-scale field experiments under suitable conditions before recommendations can be made for their general use. *Br. suis* infection in pigs, although probably not so prevalent as infections in other animals with *Br. abortus* and *Br. melitensis* causes losses in some countries. Again, although research work continues, there is little to be done for the control and eradication of the disease except the carrying out of diagnostic tests and the removal of reacting animals from infected herds.

Salmonellosis

The incidence of salmonellosis in animals throughout the world is not known. Infections of individual species of animals with types and sub-types of Salmonellae are well recognised, *e.g.* infections of equine animals sheep and poultry. On the other hand, however, acute infections occur caused by one or other of the many types, sub-types and strains of Salmonellae, the origin of which may not always be obvious. In addition to the losses in animal life and in their production from these infections, stress must be laid on the part played by animals in the occurrence of human salmonellosis. In this connexion note has to be taken of carriers of the infection which may apparently show no obvious symptoms of disease and their contamination of meat and meat products as well as by acutely infected animals and by human carriers who handle meat and meat products. The transmission of Salmonella infection through eggs is well known, some types infecting human beings and others causing heavy losses in poultry. Happily, in the case of some of the poultry infections, control measures are now in daily practice and their application is reducing incidence and resultant mortality to a marked degree.

Rabies

Although some countries are in a position to claim entire freedom from rabies, due to the precautions taken against its introduction or the successful intensive measures practised for its eradication, the disease continues to infect all types of animals, in many parts of the world. Although domesticated dogs have always been recognised as the important vectors of the causal virus, the picture has become more complicated by the discovery of the spread of infection, especially among the larger domesticated animals, by bats; only blood-sucking bats were first thought to be involved but there is now ample evidence that some insectivorous and fruit-eating bats may also convey the infection. The human population of any country in which the infection is present stands at considerable risk. Quarantine of imported canine and feline animals as carried out in countries like Great Britain, Ireland, some European countries, Australia, etc. is acting as a reliable safeguard against the introduction of rabies. We realise very clearly the pressure sometimes exerted on veterinary services to relax their quarantine measures: such services must continue to be supported fully in the stand they are taking, in spite of opposition from any quarter. Vaccination for the prevention of rabies has, as you know, been practised for many decades in the human being: more recently, following research work, the successful vaccination of dogs has been practised. The introduction of attenuated strains of the causal virus and its cultivation in the developing chicks embryo have resulted in the production of vaccines which are finding an important place in the control and eradication of rabies. In eradication schemes which have proved successful, care has to be taken to deal with the whole of the canine population in the area: thus, registration of dogs is necessary together with their vaccination, while destruction of unregistered animals, even on an extensive scale, must form part of the campaign. In countries, in which the wild animal population becomes infected, difficulties are added to any eradication campaign as, in spite of efforts to deal with them, infection continues to persist in them and so complicates the organised schemes. There are examples of schemes which showed much promise, ending in failure some of which can be attributed to wild animals. It must also be pointed out that in rabies we have an example of a disease for the control of which international action is necessary.

Swine Erysipelas

There is little doubt that swine erysipelas can be classed as an enzootic in areas in some countries. Its incidence may not be known but periodically, especially under suitable weather conditions, the disease makes its appearance. It is uncommon or even absent from many tropical areas. The evolution of swine erysipelas suggests strongly a residual soil infection, which causes disease mainly in pigs but also in lambs and young poultry. The occurrence of the disease in human beings handling infected pig meat and products is well recognised. Until comparatively recent times the only biological product available to veterinarians for use in connexion with swine erysipelas was hyper-immune serum, usually produced in horses. There was introduced, however, vaccines, generally consisting of live, sometimes attenuated cultures, of the causal organism, administered either with or without the simultaneous

injection of hyper-immune serum. Antibiotics are now finding a place in the treatment of swine erysipelas. Prevention, however, is to be aimed at for, in spite of treatment, some pigs recovering from the acute disease, may well succumb later, suddenly, from the results of the infection on the heart valves.

Diseases Transmitted by Ticks and Insects

Animals in large areas throughout the world suffer from diseases which are tickborne or insect transmitted. The causal agents vary from region to region, some being present in far separated countries, transmission being carried out by the species of the vector found in the area, especially concerning tickborne diseases. It is impossible in this review to deal with the many and interesting details of transmission, life histories or control of the agents except in general terms. Much work has been done and is still in progress, leading to a better understanding for the control of such disease and favourable results are being obtained. Because of the complex life history of most of the tickborne diseases and the vast amount of infected territories, many difficulties in control are presented. Considerable differences are found in the stages of the tick development at which transmission can occur: some species of ticks have, themselves, complicate life cycles. The study of ticks and the disease-producing agents they transmit are becoming a highly specialised subject and periodically discoveries are made of diseases not hitherto recognised as being tickborne. The following, summarised from the Report of a Joint FAO/OIE meeting on the Control of Tickborne Diseases of Livestock (FAO/56/10/8067) shows the diseases, their causal agents where known and the countries in which they occur and in which studies of transmission have been carried out.

Disease	Causal Agent	Country
Bovine babesiosis	*Babesia bigemina*	North America; South America; Australia; North Africa; South Africa; Europe; Central America.
	Babesia bovis	Europe.
	Babesia argentina	Argentina; Australia.
	Babesia berbera	North Africa.
Ovine and caprine babesiosis	*Babesia motasi*	Southern Russia; Sardinia; Romania.
Equine babesiosis	*Babesia caballi*	Europe; North Africa.
	Babesia equi	Europe; North Africa; South Africa; Central Asia.
Porcine babesiosis	*Babesia trautmanni*	Russia.
Canine babesiosis	*Babesia canis*	Europe; South Africa; India; U.S.A.; Brazil.
	Babesia gibsoni	India.
Aegyptianellosis	*Aegyptianella pullorum*	North Africa; South Africa.
East coast fever	*Theileria parva*	East, Central and South Africa.
Mediterranean coast fever	*Gonderia annulata*	North Africa; Asia Minor; Russia; India.
Benign bovine gonderiosis	*Gonderia mutans*	South Africa; U.S.A.
Corridor disease	*Gonderia lawrencei*	South Africa.
Benign ovine and caprine gonderiosis	*Gonderia ovis*	South Africa; Russia.
Malignant bovine anaplasmosis	*Anaplasma marginale*	North America; South America; South Africa; Australia; Europe.
Benign bovine anaplasmosis	*Anaplasma centrale*	South Africa.
Ovine and caprine anaplasmosis	*Anaplasma ovis*	Russia.
Heartwater	*Rickettsia ruminiatum*	South, East, West Africa
Benign bovine rickettsiosis	*Rickettsia bovis*	North Africa; South Africa.
Benign ovine rickettsiosis	*Rickettsia ovina*	North Africa; South Africa.
Malignant canine rickettsiosis	*Rickettsia canis*	North Africa.
Tickborne fever of cattle, sheep and goats	*Rickettsia sp.*	Great Britain; Norway.
Q fever	*Coxiella burneti*	Australia; U.S.A.; Algeria; Belgian Congo; Egypt; French Equatorial Africa; Morocco; Europe.

In addition, the transmission of tick paralysis is discussed as occurring in human beings, cattle, sheep, dogs, goats, fowls and on antelope, a considerable number of tick species having been shown to be vectors in North America, Europe, South Africa, Australia and Central Africa. Sweating sickness of cattle, sheep and goats is recorded as occurring in South Africa.

As can be well understood the control of tickborne diseases in general must depend upon control and eradication of the tick vectors. This has been practised for many years in infested countries largely by dipping procedures using insecticides or ticicides. Reduction of the incidence of tickborne diseases and, sometimes, their complete eradication has been accomplished. With the availability of newer and less dangerous chemical agents, with a fuller knowledge of their action and with the application of more energetic measures and practices there is already evidence of more effective results. Spraying, instead of dipping, is adopted in suitable circumstances. Nor must we forget the advances made in the preparation and use of therapeutic substances which are finding a place in the control of some of the diseases of this type. Vaccines produced from tissues taken from artificially infected sheep, have proved their value in the control of louping-ill. Premunition of susceptible cattle is also practised in some parts of the world, especially for animals to be introduced from free to infected areas or countries: an example is the use of *Anaplasma centrale* in the prevention of malignant bovine anaplasmosis.

Trypanosomiasis

The most prevalent and economically important, insect-transmitted disease of animals is undoubtedly trypanosomiasis which causes much loss of animal life and interferes markedly with animal develop-

ment in large areas in Africa and the Southern parts of Asia.

Different species of trypanosomes cause different diseases in animals. *Trypanosoma brucei, T. congolense* and *T. vivax,* individually or in combination are the important causal agents of Nagana (tsetse disease) in bovines and other ruminants, equine animals and dogs; *T. simiae* infects mostly pigs; *T. evansi* is responsible for disease in equine animals, dogs, camels, elephants and bovine animals. On the other hand, *T. equinum* (the cause of Mal de Caderas) and *T. equiperdum* (the cause of dourine) infect only horses. Nagana, transmitted mostly by the tsetse fly, is found in tropical Africa where the fly abounds; surra, transmitted by various blood-sucking insects is widely distributed, occurs mainly in India, parts of Southern Asia and North Africa; Mal de Caderas, in the transmission of which Tabanus and Stomoxys are thought to play a part, is found only in tropical South America; dourine is found in parts of Europe, Asia, Africa and North and South America and is transmitted, directly, without any part being played by vectors.

The control of trypanosomiasis is largely dependent upon the eradication of the vectors and, although this is an extremely difficult task, involving clearing of areas of vegetation, drainage, fly trapping, the use of insecticides and the elimination of game which act as reservoirs of the infection, slow but sure progress is being made in some areas. In Sudan, for example, energetic measures have been followed by results which have enabled a continuation of livestock raising in parts where, formerly, it was impossible. Much progress has also been made in the treatment of infected animals, using chemotherapeutical agents, especially those produced in recent years. The incidence of dourine throughout the world has been greatly reduced since the inauguration of suitable quarantine measures in the various countries.

African Horse Sickness

African horse sickness, of virus origin is widely distributed throughout Africa, especially in Southern, Eastern and Central areas. Sporadic outbreaks also are reported from some Near-East countries, when suitable climatic conditions are present. The infection is not directly contagious and it has been concluded that the most likely vectors are nocturnal biting insects, *e.g. Culicoides.* Spread of the disease into new regions is probably associated with the importation of carriers of the infection. Following attenuation of the causal virus by serial intracranial passage in the mouse, there has been made available a highly efficient and safe vaccine which is being extensively used in the successful immunisation of susceptible equine animals.

Bluetongue

Bluetongue (catarrhal fever of sheep), also caused by a specific filterable virus, although at one time classed as an African disease, has recently been found in parts of the Near East, North America and Europe. The disease, at one time thought to be confined to sheep, is now known to infect cattle, usually in a mild form, although recent outbreaks in Europe showed that cattle could also suffer from the disease in an acute form. It seems possible that cattle may be reservoirs of the infecting virus. The actual vectors are not definitely known but *Culicoides* are believed to play some part in transmission. The virus, attenuated by serial passage through several generations of developing chick embryos, has resulted in the availability of an efficient immunising agent.

External and Internal Parasitic Infestations

It is not possible in this article to do more than touch on this extensive and important subject. Skin infections caused by fungi and mites are world-wide, but as more and more veterinary attention is given to them, their incidence is regressing. Mange in horses is rapidly becoming a disease of the past and sheep scab is now being well controlled: the disease has, of course, been eradicated from some parts of the world, including this country. With the introduction of new insecticides which are being widely used, the handling of the animals is reduced and this makes for satisfactory results with less labour and inconvenience. In countries in which sheep raising is one of the main industries, *e.g.* some Near-East countries, there are now better attempts being made to control external parasitic infestations by the provision of dipping baths at convenient centres. International organisations are attempting to influence governments to proceed rapidly with the provision of such facilities and the use of suitable dipping agents. There is little doubt that, even in spite of the many difficulties pertaining to the treatment of sheep for the control of external parasites, much more can be done with good results by organising campaigns, the basis of which is the use of suitable chemotherapeutic agents in the form of dips or sprays. That such campaigns can be organised and applied, even in lesser developed countries, is quite evident because of the progress already made in the control of ticks in cattle. Active veterinary services with the full support of governments is badly lacking to-day in some countries and a condition such as sheep scab will never be well controlled in them until improvements take place in these services. We know what is required, we know the difficulties for the smooth running of any extensive scheme but we also realise very definitely the part that must be played by veterinarians in such work. Changes, however, are taking place and by continuous pressure by those in a position to do so, eventually a stage may be reached when schemes for the control of diseases of livestock in countries where they are now absent or poor, will materialise along satisfactory lines.

Infestations of animals, especially sheep and goats, with internal parasites are found throughout the entire world: in some countries a beginning is being made only now to ascertain the species of the different parasites but, here again, progress is being made. The use of suitable, safe, chemotherapeutical agents is increasing; there is a better understanding of the life-histories of many of the parasites and the

effects of climate on the development of the various stages, which has led to a better appreciation of the best times for the application of preventive and curative treatment; there is a better understanding of the value of the different treatments to control different species of the parasites. The results of research work in this and other countries is now being applied in many sheep-raising areas throughout the world and when recommended measures, following surveys, have been conscientiously adopted, beneficial results are already evident in more rapid development of treated animals, better breeding results and increase in wool production of better quality. Nor must we forget to mention the progress that has been made in research into immunity against certain round-worm infestations.

While most attention seems to have been given to the control of round-worm species, distomatosis has also been the subject of investigation in some parts. The species of flukes causing disease have been and are being identified along with the snail and other intermediate hosts. While it is realised that the control of liver flukes is a complex problem, attempts are being made to deal with the situation in some parts of the world. In addition to the treatment of the animal host, itself, various methods are being applied for the destruction of the snail intermediate hosts: the methods must, of necessity, vary with the snail species. Attention has been drawn recently to the effects which new irrigation schemes, some of which are extensive in some parts of the world, may have on the introduction of or on the increase of distomatosis in livestock. This is an example of the essential need for close collaboration when new schemes for improving livestock in the lesser-developed countries are being worked upon, or even in the more-developed countries: it also serves as one more example of the part which veterinarians should play in agricultural developments. Co-operation between all interested in agricultural and veterinary subjects and in human medicine is essential. It is being encouraged and in many parts is being successfully used. A simple, perhaps primitive, example may interest you and illustrate collaboration between veterinary and medical workers. In a certain area in India where liver flukes abound, both human beings and animals suffer from their infestations. The plan is to treat both the people and the animals. Attention of the public is attracted not by talks nor literature, but by men, rigged out as clowns who go to the villages and give a performance; crowds collect and as the performance is finished the clown talks a little about liver flukes. He invites the peasants to bring their animals to a certain place on a certain day. The first response may be small. Veterinarians treat the animals, medical services look after the people and encourage them to stay for the whole of the day during which samples are taken and examined. The encouragement is the provision of a meal. Any peasant found infested with liver fluke is dosed before leaving. Thus, the animals and their attendants go home, both having had whatever treatment is necessary. The news spreads, the food is good, both animals and peasants feel and look better and the numbers for examination and treatment increase: a simple but effective campaign of collaborative effort.

Mention must also be made of insects whose activities do so much damage to animals. We need only recall the extensive damage done to sheep by blowflies and the loss in value of hides and on production by warble flies. Insects causing such damage to livestock vary in different parts of the world. One of the most interesting, found largely in areas in Central and South America is *Dermatobia hominis* which attaches its eggs to mosquitoes and other blood-sucking insects: the larvae hatch out when the infested insect settles on a suitable animal —usually cattle—and penetrate the skin, causing extensive damage. Repeated and regular application of suitable insecticides at short intervals is of some value in controlling the infestation, but very heavy losses are occurring annually. It is also of interest to note that cattle infested with warbles arrive in Southern countries from Northern parts, but further development of the parasitic insect does not take place.

Diseases Associated with Breeding

It is not really so very long ago that our knowledge of causes of infertility, temporary or permanent, was very meagre. While there is still some considerable distance to go before the many causes will be well understood, especially those associated with the physiology and biochemistry of the genital system, we have made rapid progress with the control of diseases of an infectious nature spread by breeding. We may not yet have discovered all the infections of this nature and it is highly probable that some may not yet have been recognised. We do know a lot, however, about trichomoniasis and genital vibriosis, diseases which have been the subject of much research work in this and other countries. Although trichomoniasis still crops up periodically in some parts of the world, its incidence is definitely low. Enquiries on the occurrence and incidence of genital vibriosis have shown that the disease is widespread. The result of these enquiries is evidence that, if special attention is given to a disease, if much is written about it and if the interest of veterinarians is stimulated, information is forthcoming and may alter the global picture completely. The introduction of tests for the diagnosis of the presence of a disease in an individual animal or in a group of animals, especially if such tests are comparatively easily applied, has been of the greatest value in ascertaining incidence of disease.

We recognise that in some quarters there may be some doubt about the extent of damage in a breeding herd from the presence of infectious genital diseases, especially genital vibriosis. Taking quite an impartial view of the subject and reviewing the evidence accumulated from different countries we must concur, I think, with the view expressed by an FAO panel of workers on the subject that "the presence of genital vibriosis in a country constitutes considerable economic loss to the livestock industry, largely through infertility and abortions with consequent interference with breeding programmes";

and that " the present indications are that the disease is a major problem whenever and wherever it occurs." Happily, methods of diagnosis have been worked out and can be applied and breeding programmes can be so arranged that the infection can be fairly readily eliminated from a herd and normal breeding operations restored. Artificial insemination, apart from its value in improving livestock and their production, is of much importance in the control of infectious genital diseases. In discussing artificial insemination as a breeding technique, we must at once draw attention to the important and essential part played by veterinarians. We are well aware that, in some parts of the world, the tendency is to place the whole of this subject in hands other than those of veterinarians. The more we study the problem, the more we consider the careful work that it needs, the more are we convinced that the major part of artificial insemination is a veterinary problem. Fortunately for the future of the work, this view is held in many countries, one result being that in countries where the method is being introduced, the operating is being put into the hands of the veterinary services. Throughout the whole world there is probably nothing so popular to-day in livestock production as artificial insemination. Reviewing the global position, one would give a word of warning, *viz.* do not be in too great a hurry to expand artificial insemination in countries where adequate veterinary supervision is lacking: go slowly and make expansion gradual, taking note of and giving the necessary and essential attention to the many conditions which will make for the success of the method.

Other Diseases and Conditions which Interfere with Animal Production

It is impossible in a paper of this length to give detailed attention to the many diseases and conditions which interfere with the health of animals and, therefore, with animal production. We have referred to a considerable number of the major diseases but many others exist. We need only draw attention to diseases associated with nutrition and animal husbandry in general. As more and more production is required from livestock, so changes have to be made in the nutrition supplied to them for such specific purposes, and the general conditions under which the animals are maintained also undergo changes. These may have a marked effect on the health of the animals concerned. Examples are numerous. For example, the incidence of mastitis in cattle, with the involvement of different micro-organisms, rises as milk production is increased. Under primitive conditions, mastitis is reported as a rare occurrence. Again, as feeding is improved, often in the shape of improved pastures, digestive troubles arise.

There is also that somewhat extensive group of diseases associated with deficiencies. In some parts of the world, even in the better-developed countries, at times, lack of a sufficient supply of some of the major elements in feeding becomes evident: this is seen especially in sheep, when overstocking occurs in flocks kept under natural conditions without supplementary feeding and when untoward climatic occurrences become prevalent. On the other hand, deficiencies in minor elements abound throughout the world and interfere markedly with animal production unless the necessary elements are provided. Such deficiencies must be considered when new areas are opened up for livestock development. Again, in devising plans for irrigating land to increase crop and livestock production, attention has to be given not only to the effects that new crops may have on animal health but also on the introduction and conditions for development of certain types of parasites which may adversely affect animal health. With increased production, also, diseases of metabolic origin have a greater incidence and have to be taken into account.

Many diseases are omitted from this paper: some may be considered of importance, but it is hoped that the remarks now before you will, in some measure, indicate how animal diseases are distributed throughout the world; the conditions under which they exist and will continue to exist; the advances which have been made in the control of the major diseases; and the essential and important part played by veterinarians.

Disorders of the Lactating Sow and New-born Pig

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TO have much to do with pigs is to realise how strong is their instinct for survival. Both man and nature have surrounded the life of the young piglet with many perils; man has frequently compelled it to live in an environment completely unsuited to its survival; while nature, not content with making a dam's milk deficient in certain necessary elements, has, in recent years, abetted by man, so arranged matters that some sows put substances into their milk which cause the death of the piglets. In addition to these perils to its existence the piglet has to ensure that it gets adequate sustenance from a dam who is prone to lose her milk during the vital 48 hours after farrowing. Yet, despite these handicaps, the pig is reared by man for monetary gain!

Many statistics of pig losses between birth and weaning at 8 weeks have been published during the last 25 years, but the surprising feature has been the constancy of the percentage mortality over this period in spite of the knowledge which has accumulated on diet, housing and disease. Doyle in 1932 recorded that 25 per cent. of pigs died in the pre-weaning period and Reid (1935) found that there was a 21 per cent. loss on farms in Bedfordshire and Hertfordshire. In a pig loss survey undertaken by the Veterinary Investigation Officers where a number of farmers co-operated in submitting all pigs which died to the Investigation Laboratories, a 25·4 per cent. mortality occurred on the farms (Field, 1957). The National Pig Recording Scheme, covering the two years from October, 1954 to Septe mber, 1956, showed an average mortality rate of 23.0 per cent. In Northern Ireland, Gracey (1955) reported an 18·2 per cent. pre-weaning loss.

That the annual loss of one pig in every 5 born is not a feature on all pig farms, is evident from the records available from some pig-breeders who have used a variety of systems of management where the only losses are from litters containing too many pigs for the dam to suckle or where a pig is born undersized. On these premises the mortality rate may be 10 per cent. or less. To what, therefore, can one attribute the national average loss of 20 to 25 per cent.?

Most pig-breeders will agree that the highest mortality occurs in the winter months. The National Pig Recording Scheme gives emphasis to this point by showing that an extra half-pig was lost during the first 3 weeks of life in litters born in the October-March period compared with the 6 months summer period, although nearly twice as many litters were recorded in the April-September months. Both Field (1957) and Gracey (1955) commented in their survey analyses on the fact that the greatest mortality occurred in the winter period.

It is generally accepted that the greatest loss is experienced during the early days, particularly in the first week, of life. Analysis of the Veterinary Investigation Survey mortality records showed that 19·6 per cent. of pigs died in the first week compared with 5.4 per cent. for the remainder of the pre-weaning period.

Various causes have been suggested for this high mortality during the first week of a pig's life, in particular crushing has been blamed. It is probable that many pigs do die from crushing but this is the result of a train of circumstances which render the pig inactive and unable to get out of the way of the sow. The Veterinary Investigation Officers' survey indicated that of the 19·6 per cent. loss, 8 per cent. was due to crushing, 4 per cent. resulted from starvation and 8 per cent. from undetermined causes and a variety of diseases.

General Management and Nutrition

One cannot consider the disorders associated with the lactating sow and the new-born pig without keeping constantly in mind that much of the success of rearing a litter depends on the twin pillars of good management and good nutrition of the sow during pregnancy. Many of the ailments of the dam and her litter derive from a failure to fulfil the needs in one or both of these respects.

It is essential that an adequate quantity and quality of food is given to the pregnant sow all the time. When a large number of sows of different ages and sizes are herded together the bullied and weak are bound to suffer and get insufficient nutriment. Hammond (1955) in his work on pigs and sheep has shown how important it is that the pregnant animal should have plenty of good food, particularly in the last month or so of pregnancy if the offspring is not to suffer. Therefore, the smaller the group of sows kept together the better.

Stahl (1956) found that when a ration supplemented with vitamins, minerals, and proteins at high level was fed to sows for 25 days before farrowing the average pig's weight at birth was 3.4 lb. compared with 2.1 lb. of the controls, and that mortality was considerably greater in the latter group.

During the 14 days preceding farrowing the sow should be isolated though still given exercise, not overfed, and an increasingly laxative diet introduced, for constipation is often associated with agalactia. An adequate water supply before and after farrowing is essential. It is probable that the failure to observe these simple management principles contributes towards endocrine dysfunction and post-parturient fever. A failure of the milk supply or the development of mastitis can easily follow in the train of environmental conditions where the sow and litter are housed in a cold, draughty place or where the floors are damp.

The finding by Newland, McMullen and Reinche (1952) that the heat control mechanism was underdeveloped in the new-born pig gives emphasis to the importance of ensuring an environmental temperature of 70 to 80° F., particularly for the first 3 days of a pig's life, but it is not only during this short period of time that warm housing is required. Shanks (1942) has emphasized the importance of providing warm dry buildings for the successful rearing of pigs. He found that in buildings which permitted wide daily ranges of temperature the pigs would develop coughs, huddle together and indulge in such vices as savaging and tail-biting. When the environmental temperature was improved these conditions ceased to be of significance.

Many adaptations and variations of pig pens have been tried out to reduce the harmful effects of chilling. Amongst the most successful has been the farrowing crate suggested by Shanks (1948). The crate can be used in a loose-box, pen or a series of crates put in a large building. In recent years suitable modifications of the farrowing crate have been made so that it may become a permanent fixture in insulated pens.

Another useful method of giving warmth to the young piglets has been the infra-red ray lamp. Many farmers use these lamps but how often is the usefulness of this source of heat misapplied! The lamp is often placed in the corner of a pen, and some bars fixed into walls so as to enclose a triangular area where the piglets may rest under the lamp away from the sow. Such a position for the lamp can only fulfil part of its function and might, in fact, have the reverse effect of that intended. One has only to watch the drift of the smoke from a cigarette along the floor towards the heated corner, and note its upward flow to the lamp and above it, to appreciate the cold draught to which the piglets under the lamp are subjected, for all the warm air is flowing up above the lamp to the ceiling of the pen. A roof covering, or some means to stop the upward current of air and direct its flow down again, would result in a general warmth improvement of the secluded area for the piglets out of all proportion to the cost of its erection.

The subject of nutrition is so vast that only the briefest reference can be made to the importance of ensuring adequate minerals and vitamins in the foodstuffs supplied to the dam during pregnancy, and an indication given of some of the sequelae which may arise when there are deficiencies of these substances in the diet.

A maternal vitamin A deficiency was considered by Goodwin and Jennings (1958a) to be responsible for a heavy mortality and a variety of eye defects in a large number of litters in 4 herds. Field (1957) opening the discussion on a paper on pig mortality by Goodwin referred to a herd where vitamin A deficiency had been responsible for the deaths of many piglets in 11 litters on one farm. No eye lesions were observed in the piglets.

Lamont *et al* (1950) have emphasized the importance of an ample supply of vitamins to sows, particularly during the winter months even if there is access to pasture, in order to build up the reserves of the new-born pigs. They mention instances of piglets developing rickets before they are 21 days old, which would indicate that the rations to the dams were inadequate in their vitamin content.

Theoretically sows should have sufficient supplies of vitamin B complex in the normal ration and yet cases of diarrhoea and skin rashes develop in young pigs and respond when yeast is administered to the pigs.

Pullar (1950) has suggested that besides a vitamin A deficiency, the lack of such minerals as iron and calcium in the diet of the pregnant sow could be responsible for abortions and stillbirths. There are many people who claim that sows which are unable to graze on pasture during pregnancy develop anaemia and their progeny have low iron reserves, and that they show severe symptoms of anaemia early in life.

Asdell and Willman (1941) kept mortality records of a large herd over a five-year period. They observed that losses were higher in the spring than in the autumn and suggested that this might be related to the fact that, before the spring farrowings, the sows could only run for one month or less on pasture. Weipers and Inglis (1956) ran an experiment in which they compared the results obtained by rearing one group of gilts outdoors from weaning to the time they had themselves weaned litters with a group of gilts kept entirely indoors. They found that on the outdoor system the average number of piglets born in a litter was 12·0 with 9·5 weaned compared with 8·4 born and 4·4 weaned on the indoor system. The death rate was mostly attributed to crushing.

There are, however, many farms on which the sows have been kept indoors during successive pregnancies and lactation periods and yet only sustain about 10 per cent. mortality in the piglets up to 3 weeks of age which indicates that provided the nutrition and management are good a low mortality rate can be obtained under such a system.

However, it is true to say that in general it is more difficult to rear litters satisfactorily on the indoor system but losses arise more frequently when the pigs are 2 to 4 weeks old than in the first few days of life. Brooksbank (1954) reported a case of severe anaemia with heavy mortality in 3- to 4-weeks-old piglets although iron was being administered, but an immediate response occurred when copper was added to the iron. Ensuring that the diet of pregnant sows kept indoors contains copper has often had beneficial results on the successful rearing of the litters.

It is certain that other minerals besides iron and copper are essential to the well-being of the new-born pig and the idea that a simple mixture of chalk and salt is all the mineral requirement necessary for pregnant and suckling sows is quite erroneous. The mineral supplements used by McCrea and Tribe (1956) to rear piglets artificially from birth illustrates the variety and complexity of the mixtures required and if a sow is to rear a litter her mineral requirements would be just as complex as the artificial diet.

Conditions affecting Lactating Sows

The lack or loss of milk by sows during the days immediately following farrowing can have far-reaching economic results. There are a number of

factors affecting the health of the sow which are capable of inducing agalactia apart from specific infections such as swine erysipelas and swine-fever.

1. *Endocrine dysfunction*

A form of agalactia which has been recognized with increased frequency during the past few years is one in which the sow farrows with a well-developed udder apparently full of milk but she will not let the piglets suckle, or they are unable to withdraw a sufficient quantity of milk for their nourishment. The dam does not show a febrile reaction. In some cases the dam will produce an adequate amount of milk for a few hours after farrowing and then the milk supply will fail. Usually gilts are affected but second-litter sows also show the condition. Injections of post-pituitary hormones have often met with dramatic success, indicating that the condition may be due to a failure of the "let-down" mechanism.

Another form of hormonal upset is observed in sows which appear healthy but whose udder glands have little or no milk and repeated injections of pituitrin only produce a temporary response. Hogg (1952) found that injections of penicillin or calcium borogluconate or the flushing of the vagina with warm antiseptics could produce the same temporary increase in milk flow. The limited success with these diverse measures would suggest that they stimulate the "let-down" mechanism which liberates the milk available in the ducts but fails to stimulate the glandular cells into activity. Evidence has recently been produced that a form of agalactia is associated with a failure of the secretory cells of the udder to function and that anterior pituitary extracts produce the necessary stimulus.

2. *Post-parturient fever*

A condition which may spread through a herd like an epidemic is post-parturient fever, which is observed in sows 2 to 3 days after a normal farrowing. Symptoms commence with inappetence, a disinclination to let the piglets suckle the udder which is full and hard, and pyrexia which may be slight though occasionally temperatures of 104-5° F. are recorded. An observation often reported is that the hardening of the udder commences in the posterior glands and extends progressively forward. A vaginal discharge which may vary considerably in volume and may be mucoid or white in appearance is a constant feature. This discharge is not purulent and does not suggest a uterine infection.

The B.V.A. publication, Diseases of Pigs (1956), states that there is little known of the aetiology of the disease. Jackson (1952) and Hogg (1952) both considered that it was a venereal disease. This view of the method of spread may be correct as there is often a history of a group of sows or gilts being affected after having been served by a newly purchased boar.

A variety of treatments have been used with varying success. Jackson (1952) reported some success with *B. coli* serum and Hebeler (1954) with sulphonamides. More recently a fair degree of success has followed the use of antibiotics with pituitrin, provided treatment is undertaken soon after symptoms have commenced.

3. *Metritis*

Metritis is usually considered to be a disease affecting individual sows and is often associated with retained afterbirth; but Blood (1957) in Australia, described a uterine infection which involved a series of sows on two farms. Symptoms developed 2 to 3 days after farrowing, commencing with inappetence, a temperature of 105-7° F. and a purulent uterine discharge which after a time was replaced by an opaque, odourless fluid which collected in large quantities on the floor. This discharge disappeared after a few days. Although the udder appeared normal the piglets were unable to get any milk. Antibiotics proved successful in treatment. The history of the outbreaks suggested venereal transmission.

In many ways the metritis epidemic described by Blood (1957) has a resemblance to post-parturient fever though differing in the degree of uterine involvement. Outbreaks similar to that described by Blood have occurred in this country, causing serious losses in the litters from starvation. Antibiotics have met with good results. It has been observed that some degree of immunity is produced as the dams will be normal at their next farrowing though the symptoms may again be observed at a subsequent farrowing.

4. *Mastitis*

There are varying grades of mastitis from the acute to the chronic form. The latter occurs in older sows and usually involves one or two glands. Infection is deep-seated and associated with *B. coli* or staphylococci organisms. Its economic importance is that the number of glands available is reduced and at a subsequent farrowing a flare-up of acute symptoms may arise.

The acute form manifests itself within 3 to 4 days of farrowing. A varying number of glands become congested, swollen, hot and painful. The secretion often contains clots or is altered in appearance. The temperature of the sow rises to 105° F. If the intensity of infection is great a general toxaemia may develop and result in the death of the animal.

In the less severe forms the secretion is not necessarily abnormal in appearance though the glands are hot, congested and painful.

Bacteriological examination of a large number of milk samples and swabs at our laboratory has resulted in the isolation of a variety of streptococcal organisms (such as *Strep. uberis, Strep. viridans* and Group *C. streptococci*), haemolytic staphylococci and *B. coli*.

Sumner (1957) noted that there was often a constancy of the species of organisms isolated from clinical cases on any one farm. Thus in 4 herds only *B. coli* organisms were isolated, while on some other farms streptococcal organisms were predominant. Applying this observation to a method of control, Sumner was able to eliminate clinical mastitis in the 4 herds with *B. coli* infection by restricting the diet of the sows for some days before farrowing and injecting a *B. coli* serum into each sow immediately prior to its farrowing. This method of control has been used on a number of other herds with equal success where coliform mastitis has occurred.

Methods to control the condition on some farms

by isolating the gilts during pregnancy has not met with success.

In the majority of herds with *B. coli* mastitis it has been found necessary to adopt serum control measures for every animal which farrows, but occasionally the disease runs its course through the herd and then dies out with only an occasional dam showing a recurrence of the disease.

With the streptococcal forms of mastitis no control measures have met with success.

5. *Milk fever*

There are many references in the literature on pig diseases to a condition resembling milk fever of cattle, but it is probable that the condition in the porcine species is uncommon. Only one sow on a farm may be affected and the condition may not be seen again for some years. Clinically, the animal is found recumbent, there is a paddling action of the legs followed by coma. No milk can be withdrawn. Calcium borogluconate injections produce good results.

Conditions affecting New-born Pigs

In the general introduction to this paper reference was made to the survey undertaken at Veterinary Investigation Centres and that a 19·6 per cent. loss was recorded for pigs during the first week of life. Further study of this mortality percentage revealed that only 8 per cent. was ascribed to disease and undetermined causes, indicating the small part which disease alone plays in the early days of a pig's life.

The survey was continued for another year and the average mortality figures have again shown very similar results to those of the previous year (Field, 1958). The records of all deaths during the first week of life were divided into two age groups; from birth to 3 days and from 4 to 7 days. Analysis of these records has shown that crushing was considered to be responsible for nearly half the deaths and that crushing and starvation together accounted for over 60 per cent. of the deaths during the first 3 days of life. During the second period of the first week of life crushing was responsible for only half of those occurring in the first 3 days' period, but an increasingly important part was played by bacterial infections. Specific bacterial disease conditions and enteritis were responsible for 11·5 per cent. of the total mortality in the first 3 days, but in the 3 to 7 days' period they caused 21 per cent. of the deaths.

Specific Disease Conditions

1. *Aujeszky's disease*

Aujeszky's disease is a viral infection of many species of animals, producing symptoms of severe pruritus though in the pig there is rarely any evidence of this. Outbreaks occur sporadically, rarely become enzootic in a piggery, and die out as suddenly as they appear. Although reported from most European countries and Northern Ireland (Lamont & Shanks, 1939) only one case had been confirmed in England (Venn & Done, 1954).

The disease affects the younger suckling pig while the older animal may show a transient fever. Symptoms indicate that there is an involvement of the central nervous system. In the older suckling pig there is dullness, loss of appetite, muscular tremors, and the animal wanders round the pen. This is followed by convulsions and death. The very young pig develops ataxia and paddles furiously if disturbed.

The mortality rate may be high in young pigs. Lamont & Shanks (1939) reported 100 per cent. mortality in 4-week-old pigs, and Gordon & Luke (1955) also observed a high mortality rate in young pigs. Their investigation was of particular interest as it involved a large herd with pigs of various age groups being affected, including sows 2 to 10 days after farrowing. Although there was only a temperature rise and inappetence in the sows the resulting agalactia caused severe losses in their litters. Many of the young piglets stood with their backs arched, hairs erect, and died within 48 hours of becoming ill. In 3 to 4-week-old pigs there was ataxia which terminated in paralysis. Muscular tremors and fits were also observed. The outbreak was considered to be associated with a low vitamin A intake of the sows during pregnancy which may have predisposed the breeding stock to the virus infection and as a result of passage the virus was enhanced and spread to the young pigs.

2. *Leptospiral infection*

Various leptospiral organisms are associated with infections in pigs but *L. ictero-haemorrhagiae* is the only one proved to cause disease in pigs in this country (Field & Sellers, 1951). It usually affects pigs 1 to 2 months old, particularly in the winter months on rat-infested premises. A number of pigs in a litter are affected, have a temperature around 105° F. and then in 2 to 3 days they develop jaundice. It is not uncommon for recovery to occur.

Leptospiral organisms have been found to cause sows to abort 2 to 3 weeks before farrowing-time or carry their litters to full-time and then farrow a number of stillbirths and live piglets which are weakly, usually undersized, and which die within 1 to 4 days (Ryler & Simmons, 1954; Powers *et al.*, 1956).

The urine of infected rats is considered to be the common source of infection. Pigs which recover may remain carriers. There is evidence that the organism can be excreted in the urine of pig carriers for as long as a year after infection.

Michna (1958) has examined a number of pig sera in this country and found that over 50 per cent. of the samples contained specific antibodies to various types of leptospira. This would suggest that many carriers exist and that many pigs become infected without showing clinical symptoms. Personal experience with a limited number of blood samples taken from sows during investigations of possible causes of abortion and mortality in young pigs has not confirmed this suggested high incidence of infection in pigs. A high carrier rate in the pig would be important from two aspects. The pig would act as a reservoir for transmitting the organism to other livestock on the premises and to man, particularly those in the meat supply trade.

3. *Haemolytic disease due to iso-immunisation*

The various clinical forms of haemolytic disease of the new-born have been recognised for centuries in human medicine. It was not until 1940, however,

that the theory of iso-immunisation began to take its present form, when Landstiener & Wiener (1940) reported that by immunising rabbits with the red cells of rhesus monkeys they produced an antibody which could agglutinate not only the red cells of the monkey but also of a large proportion of the human population. It was found that haemolytic disease might occur when a rhesus negative woman carried a foetus with a rhesus positive antigen.

Haemolytic disease can also be produced following the injection of rhesus positive blood into a rhesus negative woman. Goodwin, Saison & Coombs (1955) working on pigs, have also shown that certain types of vaccine when inoculated into adult females could stimulate the production of red cell antibodies which might result in the production of haemolytic disease in their progeny.

Jaundice of the new-born animal has been observed in the domestic animals for many years. Following the work done in human medicine, haemolytic disease was first recorded in mules by Caroli & Bessis (1947) in France, and in thoroughbred foals by Coombs *et al.* (1947) in Great Britain. The disease was first described in pigs by Szent & Szabo (1952) in Hungary, and by Buxton & Brooksbank (1953) in this country.

The clinical symptoms in the human child result, in certain circumstances, from the mating of a rhesus positive male with a rhesus negative female. The foetus inherits the antigen from the male and this is passed to the female, against which she produces an antibody. This antibody when taken by the child, as in the colostrum, has the property of rapidly destroying the red blood cells causing anaemia and jaundice.

In a typical case in a litter of piglets, symptoms of drowsiness and inappetence are observed about 24 hours after suckling and this is followed by jaundice at 36 to 48 hours. Death might rapidly follow or a slow recovery occur, depending on the rapidity of the destruction of the red cells. If a pig can survive for 6 days it will recover, as the production of red cells is very rapid. Although the majority of a litter will show symptoms of jaundice, some individuals may only develop a severe anaemia and slowly recover, provided no bacterial infection supervenes.

Occasionally a very acute form develops in some individuals in a litter with the complete destruction of the red cells within 12 to 24 hours of birth. There is no evidence of jaundice but the piglets become markedly white. Doll & Brown (1954) observed such symptoms affecting 2 successive litters of a sow.

The *post-mortem* picture of very acute cases shows the musculature to be extremely pale, and the blood in the heart and blood vessels very watery and devoid of red cells. When jaundice is evident in the skin, the liver appears orange-red, the kidneys dark, and the urine in the bladder is dark red. The two striking features are the presence of a quantity of blood-stained fluid in the peritoneal cavity and an enlarged dark spleen.

4. *Trembles*

The condition known as trembles in young pigs may affect whole litters or only some individuals of a litter, and is characterised by symptoms of trembling or shivering from the time of birth. The degree of trembling varies in intensity, usually affecting the hindquarters, though sometimes the whole body. Death, which may occur within a day or two after birth in those severely affected, is probably caused by lack of nourishment since these piglets have great difficulty in feeding. Those showing less severe symptoms appear normal when asleep or lying down, and tremble only when roused or made to move. Not all individuals in a litter are affected to the same degree and some members may not show any symptoms. The milder the trembling the greater is the chance of recovery, though this may take up to 20 days, which suggests that any damage done to the brain may be overcome by post-natal development. Occasionally other litters, born about the same time, may be weakly, or have abnormalities.

Hughes & Hinman (1936) described the symptoms in some members of 2 litters which gradually recovered. They could not suggest a cause but mentioned that a similar condition had been seen in guinea-pigs. They also referred to an article by Hutt & Child (1934) on tremors in chicks with symptoms varying from slight shaking to inability to stand, which were ascribed to hereditary factors. Knilans (1936) reported on 5 litters affected out of a group of 12, and although unable to find a cause, he suggested that the condition might be dietetic in origin. Lamont (1950) investigated a case and mentioned a possible resemblance to Krabbe's disease in man where there is an immaturity of muscle fibres.

Since the studies of the effect of maternal rubella infection on the human foetus (Gregg, 1945; Albaugh, 1945) a new concept has arisen of the role which environmental conditions might play in affecting the embryo. Swan *et al.* (1946) investigated rubella infection in Australia and showed that certain malformations of the embryo developed if the mother was affected with the disease during the first 2 months of pregnancy.

Work done by Landauer (1948), Wolff (1948) and others had indicated that there are periods when certain cells of the embryo are in an excessively rapid stage of growth compared to other cells. These periods are known as "sensitive periods" and at these times the cell groups in rapid division become temporarily susceptible to some outside influences. Not all cell division groups are in "sensitive periods" at the same time but the periods do occur in early embryonic life. When the "sensitive periods" for a particular group of cells have passed it has not been possible to induce malformations by applying agents to those cells.

Brooksbank (1955) investigated 9 cases of trembles and found that swine fever virus was implicated in 8 of them. He suggested that any virus which could enter the foetus and infect the nerve cells of the corpus striatum in their "sensitive period" could cause trembles.

Although diets were varied and adequate in the cases investigated the condition might result from faulty diets if these could induce an upset of the growth rate of the diencephalon in its period of rapid growth.

Brooksbank suggested that a virus capable of passing the placental membranes would have to infect the foetus during the second and fourth week of pregnancy to produce the condition. Loosemore (1958) investigated an outbreak of trembles and found that the symptoms were observed in piglets of sows and gilts which were less than 25 days pregnant at the time of contact with a purchased gilt, later suspected of introducing inclusion-body rhinitis, while other breeding stock more than 39 days pregnant produced normal piglets.

5. *Swine erysipelas*

Although *Erysipelothrix rhusiopathiae* is most frequently seen in large store and fattening pigs it will infect a group of sows and cause an abortion storm. Occasionally it will affect a sow 2 or 3 days after farrowing, causing inappetence, a temperature reaction of 104-5° F. and agalactia. Although antibiotic treatment will cure the sow the litter dies from a septicaemia caused by the organisms, or from starvation.

The chronic form with lesions of vegetative endocarditis may cause the death of a sow about farrowing time. Symptoms of respiratory distress when the sow is disturbed or made to move round the pen lead one to suspect that the animal is affected with the endocardial form.

There is a possibility that the chronic form might be mistaken for a condition described by Austvoll (1958) as heart failure. It is observed in fat sows getting little exercise. A few days before farrowing they show increased respiratory movement, are disinclined to move about and develop a bluish discoloration of the belly, ears and snout and die just before or after farrowing. Austvoll has successfully treated 5 cases with pentazol. It is probable that this condition is as prevalent as the chronic form of erysipelas.

Erysipelas may develop in pigs 7 to 10 days old and after showing a high temperature reaction they usually die in 24 to 36 hours. Sindrey & Creyke (1948) observed one such case when only some pigs in a litter were affected and the sow was healthy.

6. *Clostridium welchii infection*

Field & Gibson (1955) found that *Cl. Welchii* type C might cause severe mortality in piglets under 72 hours old. The death rate was usually high in a litter. While it was usual to get a succession of litters affected it was not uncommon to find an individual litter involved on some premises.

The piglets are born healthy but with 12 to 24 hours they become dull, disinclined to move and die within 36 hours. Many of the piglets have red-stained faeces and a reddening of the anus in the terminal stages of the disease. In some instances symptoms may not develop until the pigs are 3 or 4 days old and it is a further 2 or more days before they die. In these cases there is only a severe diarrhoea.

In the younger pigs the *post-mortem* picture shows a haemorrhagic inflammation of the jejunum often extending into the ileum and the contents are blood-stained. In the slightly older pigs the inflammation of the jejunum is less intense and the contents more gaseous so that they appear, from the peritoneal surface, to be yellow-orange in colour and mixed with small blood clots.

Field & Gibson found that lamb dysentery serum was of value as a prophylactic measure if given within 12 hours of birth. They found that the organisms were on the skin and in the faeces of the dams which acted as healthy carriers.

7. *Transmissible Gastro-enteritis*

A disease characterised by diarrhoea, rapid loss of weight in pigs of all ages, vomiting in some cases and a high mortality in baby pigs was first described in America by Doyle & Hutchings (1946). They were able to transmit the disease by exposing healthy baby pigs to contact with ailing animals and by inoculation of bacteria-free filtrates into young pigs.

There have been indications from various parts of this country over the past 3 years of isolated outbreaks of a similar disease which caused a very high mortality in pigs up to about 2 weeks old. The infection was observed to spread rapidly through a piggery with an incubation period of about 4 days. Pigs of all ages, including adults, developed a diarrhoea which was very watery and yellow to brown in colour. Mortality in weaned pigs was uncommon. The condition persisted on the premises as long as susceptible litters continued to be born.

Goodwin & Jennings (1958b) have recently described such a disease and have reproduced it experimentally. They observed that vomiting might occur in some of the older unweaned pigs and that the diarrhoea only persisted for a few days in the stores and fattening pigs. *Post-mortem* findings of the pigs under 2 weeks of age, in which age group the majority of deaths occurred, showed a severe gastritis, a varying degree of enteritis and a marked congestion of the meninges.

Infection would appear to be maintained on a farm by successive litters, farrowed at close intervals, becoming infected. In America a complete break of 3 to 4 months in the breeding programme is recommended. Stevens (1958) observed that the disease dies out naturally in a relatively short period of time provided there is an interval of 3 to 4 weeks between the time of the initial outbreak and fresh litters being born on the premises. It is also advantageous to ensure that all the breeding stock have an opportunity of becoming infected in the early stages of the outbreak and of developing an immunity.

Although the history of diarrhoea in different age groups of pigs and a severe mortality in young pigs might indicate that the outbreak was due to transmissible gastro-enteritis it would always be advisable to ensure that the symptoms were not caused by swine fever.

8. *Swine Fever*

No paper on diseases of pigs of any age would be complete without a reference to swine fever.

Although constipation is not uncommon in individual newly-farrowed sows, a history of a number of sows being constipated about the same time should make one think of the possibility of swine fever.

The early stages of an outbreak of transmissible gastro-enteritis also bear a marked similarity to an attack of swine fever on a pig-farm.

With the diagnostic methods now available, such as the histological examination of the brain, with a probable 90 per cent. accuracy (Done, 1957) and the gel-precipitin test on the pancreas (Mansi, 1957), it is now possible to make a quick and accurate diagnosis and to differentiate between swine fever and other diseases.

9. *Specific Hereditary Defects*

In the Veterinary Investigation Centres' survey (Field, 1958) defects surprisingly accounted for almost 5 per cent. of the losses before weaning.

One-third of this percentage was due to atresia ani. An interesting feature of this condition is the length of time a pig may survive; some piglets live as long as 8 to 10 days.

Among congenital abnormalities which result in the death of the pig soon after birth, usually from starvation, are defects of the snout. These may take the form of a missing lower jaw, an elongated upper jaw giving a trunk-like appearance to the organ, or an abnormally long tongue which cannot be kept in the mouth. These defects usually affect the majority of a litter. Most of the abnormalities have been observed recently in the Landrace breed but it is probable that the economic value of the breed has brought these defects to light.

A defect which caused serious economic loss to one farmer and affected Large White pigs was a defective vertebral column development. The pigs had difficulty in moving and getting nourishment. On examination, the piglets appeared normal except that they had no tails and digital pressure in the sacral area caused a marked depression of the skin due to the absence of the bones in that area (Brooksbank, 1958).

Non-specific Conditions

Crushing and starvation has been blamed for about 60 per cent. of the mortality of pigs under a week old. It is probable that baby pig disease, nutritional deficiencies of the pregnant sow and management faults are together responsible for many of the piglets being crushed or starved.

Baby Pig Disease

In a typical case of baby pig disease, the litter is born healthy and active, but any time between 24 to 48 hours after birth symptoms of shivering, dullness, and inappetence develop. The piglets isolate themselves, become inactive and lie down. There is no fever, and in the terminal stages the temperature may be subnormal, with the skin becoming cold and clammy. The piglets finally lapse into a coma, though, before death ensues, some may develop convulsions with head retracted, forelegs producing galloping movements and the hind legs drawn forward to the abdomen. Death may occur within 24 hours of the first symptoms being observed. There is no apparent illness of the dam and the milk supply may be adequate.

Litters of both sows and gilts are affected though the disease is more prevalent in piglets farrowed by gilts. The condition often appears in a succession of farrowings with a mortality rate which is usually high.

There are no characteristic *post-mortem* lesions. In some specimens there may be a large curd present in the stomach but in other piglets the stomach is empty as if the piglets had not taken nourishment. None of the organs show any specific macroscopic abnormalities.

Graham, Sampson, & Hester (1941) found that there was an acute hypoglycaemia in piglets naturally affected with the condition and that prompt treatment with dextrose produced favourable results. Subsequently they showed (1942) that starvation alone could produce a hypoglycaemia with symptoms resembling baby-pig disease, provided the piglets were deprived of milk within 4 to 8 hours of birth. The longer the period during which the piglets could get milk before they were starved the less likely were they to develop the syndrome.

Graham and his colleagues as well as Goodwin (1955) in this country, have shown that a rapid depletion of liver glycogen occurs during fasting in the early days of a piglet's life and that the glucose concentration in the blood during this period fluctuates with the quantity of milk intake. This would indicate that the glucose regulating mechanism is not functioning properly in the new-born pig during its first few days of life. The importance of having dams of good milking capacity which can give an adequate and frequent quantity of milk to the piglets is thus emphasised.

Investigating the body temperature adaptability of the baby pig, Newland, McMillen & Reinche (1952) found that the heat regulating mechanism was not fully developed in the new-born pig and although it had improved within 24 hours it was not, even then, functioning properly. They noted that a body temperature drop of 3° to 13° F. occurred during the first 30 minutes after birth and that the degree of fall was related to the environmental temperature. There was a gradual return to normal within 2 days when the environmental temperature was in the region of 60° to 75° F. but the body temperature drop was much greater and took up to 10 days to return to normal if the surrounding temperature was near freezing point. The weight of the pig at birth could also influence the primary drop in body temperature; a greater fall being observed in pigs under 2 lb. than in those above this weight.

The blood sugar is used by the body as a defence against cold and its level in the blood is maintained primarily from the glycogen reserves in the liver. The lower the environmental temperature and the smaller the weight of the pig the more rapidly would the glycogen reserves be used up and a state of hypoglycaemia induced. The converse is equally correct, for the warmer the environment, and the greater the weight of the pig the less are the demands on the glycogen reserves and the quicker will the body temperature reach a normal level in 24 to 36 hours.

The pig appears to be peculiar in its inability to withstand a short period of starvation, for the new-born of other species, such as the lamb and calf, do not develop hypoglycaemia even when starved for prolonged periods of time (Goodwin, 1955).

As a result of his extensive study of the pig, Hammond (1955) states that the pig is the most

immature of all farm animals at birth, being less than 1 per cent. of its mature weight; the comparative figure for the foal is 9 per cent. Hammond lists a number of factors which may influence the birth weight, apart from the nutrition of the dam during pregnancy. Thus the number born in a litter can affect the individual weights, so that litters of less than 7 will be heavier than litters of 10 or more pigs. The size of the dam in a breed as well as between breeds can influence the weight. The age of the dam is important, for young dams produce lighter litters because the maternal tissues are not fully developed and compete with foetal tissues for nutrients. Hammond also observed that the new-born of less than average weight which might be due to under-nutrition of the dam, multiple births, etc., were physiologically and anatomically younger than normal and this was particularly so in the development of the heat regulation system.

It is possible that in some instances where a succession of litters is lost, particularly of gilts or after the introduction of a new boar, that the progeny may be hereditarily immature as they are born at the early end of the average gestation period. It is very evident that 24 hours or even less may have a great influence on the maturity of various organs of the new-born.

Apart from the factors already mentioned and agalactia of the sow, it is possible that a variety of organisms, particularly *B. coli* and streptococci, by producing a septicaemia could cause the piglets to huddle away from the sow and so develop hypoglycaemia through lack of nutrition.

Baby pig disease is thus seen to be a name for a syndrome occurring in a particular time interval and is not a condition resulting from the effects on the piglet of one specific aetiological factor.

Other Conditions affecting Young Pigs

Only the briefest of references will be made to a number of conditions which, in the strictest sense, produce clinical symptoms in pigs over a week old although infection may have taken place soon after birth.

1. *Streptococcal infections*

Umbilical infection, as seen in the calf, is not so common in the young pig but there are two bacterial infections which suggest an umbilical origin. One of these is a joint infection, particularly when the environment is cold or dirty. Usually the knees and hocks are affected and there is swelling with pus present in these areas. Although some cases may be due to infection from local injury, many are systemic in origin. Organisms isolated from infected joints include *B. coli* and a Haemophilus. The second umbilical infection takes the form of a paralysis, usually of the hind quarters, in pigs aged 10 to 14 days. Field *et al.* (1954) showed that many of these cases were due to a streptococcal meningitis. Harding *et al.* (1957) described a polioencephalomyelitis of viral origin, named Talfan disease, which produced a clinically similar disease to the streptococcal infection. While streptococcal meningitis can be treated with antibiotics, the virus does not respond. It is therefore advisable to submit specimens to a laboratory to get a correct diagnosis

2. *Rhinitis*

A form of rhinitis may affect litter after litter in some piggeries or sweep through all the unweaned pigs and then disappear. Retarded growth rate usually associated with diarrhoea when the pigs are 3 to 5 weeks old is the main economic problem. In some cases Inclusion-body rhinitis has been diagnosed but in other outbreaks there is a non-specific form of rhinitis. Sneezing is a common symptom and may commence soon after birth or not until the pigs are 2 to 3 weeks old. The retarded growth rate is not severe unless diarrhoea persists, nor is there such nasal distortion as occurs with atrophic rhinitis.

3. *Skin conditions*

There are a number of conditions which produce clinically similar skin lesions, including swine pox, vitamin B complex deficiency, sarcoptic mange and an allergic skin eczema due to forage mites. The last condition is most common in pigs fed on early weaning diets. There is also a skin condition which might be of hereditary origin. In one such case an eczema developed on the snouts of pigs in some litters of Landrace breed. The lesions started soon after birth and then spread to the ears and body. Two of the females which recovered were kept for breeding and their litters in turn also developed the skin lesions.

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THE SPEAKER'S INTRODUCTION

Mr. N. H. Brooksbank said that he had attempted in the paper repeatedly to emphasise the importance of management and diet of the pregnant animal to ensure that the new-born pig started life with the best advantage. The author said he desired to elaborate that theme by showing some slides.

At irregular intervals over the past few years, piglets of various ages, particularly those up to 3 days, had been weighed as well as some of their organs and histological material prepared from the latter. While preparing a paper for the Congress he examined some of the data collected, particularly relating to the thyroid gland.

The result was that broadly speaking there were 3 groups into which the histological pattern of the thyroid gland fell in the pig up to 3 days of age.

Group 1 could be described as the normal picture. It was interesting to note that there was often a relationship between the weight of the thyroid gland and that of the pig.

Thus pig weight was	2 lb. 0 oz.:	thyroid was	0.20 g.
" " "	"	3 lb. 0 oz.:	" "	0.26 g.
" " "	"	2 lb. 3 oz.:	" "	0.21 g.

The histological appearance of such thyroids showed large cells, cubical to columnar lining average size acini, which contained well-stained colloid. Interstitial areas were full of cells and developing acini—a common feature in the young. The history of the causes of deaths were various, such as starvation, baby-pig disease syndrome, bacterial infections, and so forth.

Group 2 showed thyroids which had a weight ratio always in excess of the pig weight when compared with Group 1.

Thus pig weight was	2 lb. 1 oz.:	thyroid was	0.28 g.
" " "	"	1 lb. 13 oz.:	" "	0.26 g.
" " "	"	2 lb. 3 oz.:	" "	0.30 g.

Histologically the thyroid showed flattened cells lining large and small acini, pale colloid. The interstitial tissues showed few cells and little activity.

The histories of that group showed that 4 out of 10 came from swill feeding establishments; one where gilts had been purchased closer to farrowing time than was expected; and a case of feeding fattening meal to the pregnant animals.

Group 3 showed that the thyroid weight ratio to pig weight was always less than those in Group 1.

Thus pig weight was	2 lb. 8 oz.:	thyroid was	0.13 g.
" " "	"	2 lb. 4 oz.:	" "	0.14 g.
" " "	"	3 lb. 4 oz.:	" "	0.22 g.

An interesting feature of that group was that the pig weights were above normal. Histologically there was variable cell reaction in small acini which were often depleted of colloid. The main feature was the lack of development in the interstitial space and the large quantities of blood present. The histories of cases in that group included vitamin A deficiencies, feeding diets low in protein and minerals, and inaccurate home mixing of meal.

The Opener

Dr. D. Luke, in opening the discussion, said that faced with such a formidable title as "Disorders of the Lactating Sow and New-born Pig" any author might well flinch. Mr. Brooksbank had coped manfully with the odds and deserved best thanks for presenting concisely a great amount of information on a wide variety of conditions. Nevertheless, with such wide terms of reference and the limitations of space, a paper tended to become a descriptive catalogue of everything which might conceivably pertain to the omnibus title. Dr. Luke suggested, therefore, for serious consideration by future committees that titles of papers should be less discursive and that prospective authors might even be consulted as to the suitable subject matter, so as to allow the subject chosen to be covered in some detail, and enable readers to benefit from the author's own special knowledge and experience. Not that the review article did not fulfil a useful purpose, but even there the field should be restricted to reasonable proportions.

The author set the scene very rightly by emphasising the appalling wastage of young pigs as shown by mortality surveys. Most of the figures quoted referred to the period "birth to weaning" which, if it did make a somewhat liberal interpretation of the term "new-born," served to spotlight the urgent need for a co-ordinated investigation into the causes of early mortality. Unfortunately, the cause of those early losses in young pigs was all too seldom the result of specific disease, and anyone carrying out *post-mortem* examinations on that age group had to confess too often that the cause of death could not be determined with certainty. There was no doubt but that a defective environment or faulty husbandry might contribute to that early mortality; but in all the studies and resulting modifications of environment and management with which those in Northern Ireland had been associated, least impression had been made on the losses over that initial first week. Some figures had been collected at Stormont which referred to the period 1 to 6 days. In one 3-year period in a total population of 24,915 the average annual mortality birth to bacon weight was 17.2 per cent., and 8.5 per cent. of that mortality occurred in the period 1 to 6 days, which meant that 50 per cent. of all losses occurred in the first week after birth.

Dr. Luke agreed with that which had been said about crushing. Crushing might provide an acceptable diagnosis on occasions, but it did nothing to elucidate the underlying trouble. There were, of course, certain sows which appeared to be temperamentally unsuited for maternity, and such would succeed in damaging even the most agile of piglets. Those sows might be tranquillised into a reluctant acceptance of their destiny, but the enquiring veterinary surgeon should not be content to let matters rest without probing to find the underlying exciting cause. In that connexion much could be done by selecting sows for docility and the frequent handling of breeding stock was time well spent.

Under the heading of "General Management and Nutri-

tion" there was little that required comment. It was noted that on some farms where the management of the breeding stock was regarded as excellent, the haemoglobin content of the blood of the sows tended to fall slightly with advancing age, and that drop appeared to be associated with a slight drop in average birth weights. An iron supplement added to the diet of the sows improved both those factors.

With regard to the use of the infra-red lamps, he would go further and say that the lamp should be enclosed in front as well as the top and a small pop hole provided for the use of the piglets. When the lamp was enclosed in that way it was often sufficient to use a 150-watt lamp instead of the larger 300-watt bulb, and that could be a considerable saving in electric current.

Dr. Luke hesitated to accept the argument that because the artificially reared piglet appeared to require a very complex mineral supplement, a similar supplement was needed by the breeding sow which could tap sources of minerals denied the artificially reared young pig. Certainly the simple mixture of chalk, salt, and possibly steamed bone flour seemed to be adequate on many farms where in-pig sows were kept outside, although he sometimes wondered whether all the salt usually fed was really necessary. He agreed, however, that the nutrition of the sow was of prime importance and overfatness in particular was to be avoided since that could be associated with a variety of happenings at parturition, none of which were to the pig keeper's advantage.

The author had assembled an imposing list of 18 more or less distinct conditions which might jeopardise the well-being of the lactating sow and young pig. Some of the conditions were in the nature of pathological curiosities to many, even though they might be well versed in the day-to-day troubles on the pig farm.

There were many baffling aspects in the various conditions manifesting themselves in agalactia in recently farrowed sows, and there was far too much empiricism in the treatment of those conditions. There was no doubt but that the nutritionist had helped to lessen the economic impact of agalactia by providing sow milk replacers, but most would agree that that at best was a first-aid measure, and it had to be admitted once again that we were in a realm where speculation was all too rife and facts were hard to come by.

Nature had made many varied and wonderful provisions for the perpetuation of the species, and it was very odd that those provisions should fail as often as they did in the case of the pig. Why should apparent endocrine dysfunction afflict the sow? What was the relationship between post-parturient fever and metritis? Those and many other questions readily suggested themselves and stressed the need for a proper pathological investigation of that important syndrome. Most veterinary surgeons had by a process of trial and error, involving often the art rather than the science of veterinary medicine, worked out a reasonably satisfactory line of treatment, but unless that treatment could be given early, the restoration of the milk supply did not take place. Post-parturient disorders tended to become established on some farms and there might follow a regular pattern, but that was not always so. On such farms it was helpful to have the temperatures checked for 2 to 3 days after parturition, and any sow whose temperature rose above 103° F. should be treated. In that way the condition could usually be controlled before any loss of milk had taken place.

All investigations reported on the variety of bacterial types associated with the conditions under review, but so far the precise causal relationship between the bacteriological findings and the condition in question had not been determined. In a series of cases on one farm the same type of bacteria tended to occur and in his experience that type was often a strain of *E. coli*. On the small farm with a few sows farrowing at well-spaced intervals, sporadic outbreaks were met with but it was on the larger establishments with a series of sows farrowing in close succession that those disorders might assume epidemic proportions. On such farms it was found that isolation and scrupulous attention to hygiene were not enough to control the sequence of events. Acute hypocalcaemia occurred in the pig, but in his experience it was rare and in many cases death took place very soon after the onset of symptoms. What appeared to be a more chronic form of hypocalcaemia was seen by some of his colleagues in Northern Ireland, and that might be associated with a prolapse of the vagina.

Even in Northern Ireland Aujeszky's disease was still something of a curiosity, and the epidemiology of it was virtually unknown. Leptospiral infections, too, were rare and since such were normally seen in pigs over one month old, the condition hardly qualified in the present context. He had not seen haemolytic disease, but that may be due to the fact that crystal violet vaccination was not carried out in Northern Ireland. It would be of interest if the author could state whether the condition was widespread in England. Did it occur commonly in the absence of vaccination?

Trembles could occur in a variety of breeds and their crosses, and the concept that the condition arose due to a virus passing the placental barrier and damaging certain nerve cells of the corpus striatum in their "sensitive period" was an interesting one, and was the most acceptable of all the various theories which had been put forward from time to time to explain that intriguing condition.

Dr. Luke had nothing to add regarding swine erysipelas, and he had not seen any condition which resembled Austvoll's heart failure. *Clostridium welchii* infection in piglets was mainly sporadic, but a succession of litters on any one farm might be lost. Available control measures were reasonably effective.

Experience indicated that in the aggregate the various enteric disorders were by far the most important and widespread causes of mortality in new-born pigs. He was sorry to see the author perpetuate that unsatisfactory term "Transmissible Gastro-enteritis." Under farm conditions there was more than one type of gastro-enteritis which might spread within a susceptible population. It was true that Goodwin and Jennings described under the title of "A Highly Infectious Gastro-enteritis of Pigs" a condition apparently due to a virus, but Dr. Luke was not aware that that disease had been shown to be identical with the condition in America described by Doyle and Hutchings. He agreed that there were reports from various parts of the country of heavy mortality in young pigs associated with diarrhoea, but it would be unwise to assume that that condition was of virus origin in every instance. On the other hand, a condition which his colleague, Mr. Gordon, and he described under the title of "Gastro-enteritis in Young Piglets Associated with *E. coli*" had much in common with the published accounts of transmissible gastro-enteritis as it affected the new-born pig. That form of gastro-enteritis occurred mainly in sucking pigs within the first 4 to 6 weeks of life, but its most devastating form was seen in new-born litters. In almost all the outbreaks investigated the same serological type of *E. coli* had been found. Recently Dr. Luke and his colleagues had found the same strain of *E. coli* in swabs sent to Stormont from 2 farms in England where there was a history of acute scouring in young piglets. The results of vaccinating sows with their killed vaccine continued to be gratifyingly good, even if difficult to explain on conventional immunological grounds. It was also of considerable interest that the incidence of post-parturient troubles in vaccinated sows was extremely low. The apparent success of the *E. coli* vaccine in controlling such conditions in sows pointed to the possible aetiological significance of that infection on those farms.

In the diagnosis of swine fever the histological examination of the brain had been found to be of considerable help in clarifying and hastening diagnosis. The gel precipitin test, using pig pancreas, appeared to require a rather specialised interpretation, and he asked the author for his opinion of that test in the routine diagnosis of swine fever.

Dr. Luke joined with the author in underlining the importance of specific hereditary defects. They were far too common even in some pedigree herds. The fact that 5 per cent. of all mortality in one survey was attributed to such defects would seem to indicate a lack of awareness, real or contrived, on the part of breeders as to the significance of those defects.

He did not like the term "baby-pig disease." That young piglets might die as the result of a hypoglycaemia was now well established, even although that starvation syndrome

might occur without any apparent loss of milk by the sow. The anatomical and physiological immaturity of the pig at birth had been shown by many investigators. The precise significance of that immaturity was not yet fully appreciated, but it might explain some of the sudden crises which could afflict the new-born pig.

Parturition in the breeding female and the adaptation of the new-born to an extra-uterine existence were rightly regarded as important and often difficult phases in the pig's life, and veterinary surgeons might from time to time tend to lose sight of the many occasions when those events took place without loss. In the paper under discussion many of the possible pathological hazards which might have to be surmounted on those important occasions had been dealt with in a very acceptable manner. In addition the paper had served to emphasise, if indirectly, the scanty knowledge available concerning many of the ills of the lactating sow and its new-born piglet.

The Discussion

Mr. G. V. Short (Wilmslow): "Was the pig scour Dr. Luke saw Northern Ireland, and which responded so consistently to a formalised vaccine, associated with haemolytic or non-haemolytic strains of *E. coli* and did his experience show any correlation between the condition and antibiotic supplementation? Dr. Luke's control by vaccination had, unfortunately, not been attained consistently in other parts of the U.K., and there was a considerable literature on the correlation of *E. coli* strains resistant to antibiotics, particularly to the tetracyclines. These strains may also resist chemotherapy, alone or combined with antibiotics. Against such strains effective vaccines may be made, but in at least one series of critical experiments the rapid development of new serotypes within 3 to 4 weeks had made such vaccines practically useless.

"Dr. Buxton, in his paper on 'Salmonellosis in Animals,' has reminded us that the customary group classification of bacteria as pathogenic or non-pathogenic cannot be applied to the gut flora in general or to the *E. coli* group in particular. Similarly, Dr. Lovell, in his review of similar conditions in young calves (*Vet. Rev. & Annot.*, April, 1955), reminds us of what we may learn from human medicine by quoting Spence (*Lancet*. **1**. 777): 'an organism such as *Bact. coli* which is relatively innocuous to older children may cause a rapidly fatal illness in a new-born infant, and an investigating bacteriologist with fixed ideas of what are pathogenic organisms may be led astray.'

"It would seem that a sufficiently clear and stable pattern is emerging to suggest that the pig-breeding industry might be better advised to supplement feedstuffs with penicillin, accepting the rather lower conversion efficiency of this antibiotic compared to the tetracyclines but gaining, in return, freedom from the risk of producing and maintaining antibiotic-resistant strains of *E. coli*, and safeguarding the efficiency of full therapeutic treatment of those antibiotics active against the gram-negative bacteria."

The Replies

Dr. Luke, in reply to the discussion, said he was particularly interested in Mr. Short's remarks regarding the emergence of new sero types under the influence of antibiotics. He looked forward to the published accounts of that.

Mr. Short mentioned haemolytic *E. coli*-resistant strains. They may have been fortunate in that the particular strain used for vaccine production was non-haemolytic. Antibiotics were still being used in Northern Ireland, and while Dr. Luke tried to keep an open mind on the subject, as the years went by the effort required increased!

What the significance of tetracycline was he could not say. If any drug was continuously put in the food of any animal the gut organisms soon became resistant to whatever preparation was being used. The widespread use of antibiotics by farmers merely led to the emergence of the resistant strains. A re-appraisal of the possible effects of the various preparations was needed. The average farmer had no clue whether he was obtaining a result or not from the use of antibiotics as a growth stimulus.

The question of the use of chemotherapy in the sows before farrowing as opposed to vaccination was raised. He had tried everything in the control of the disease, and it was a last ditch expedient when he went to the trouble of preparing a vaccine. Commercial vaccines and sera often helped at first but they seemed to lose their edges as time went on.

He did not want it to be thought that he did not agree with the report regarding the existence of virus condition associated with enteritis. He objected to the application of "transmissible gastro-enteritis" to it.

There was a period when haemolysis used to be associated with pathogens in classifying strains of *E. coli*, but most people now regarded this feature as incidental.

Mr. N. H. Brooksbank, in reply, referred to the question of haemolytic disease and said that, surprisingly enough, he did not see a great deal of it. In his own experience it had always been associated with vaccinated herds. He had not seen any cases in the natural form.

On the question of "transmissible gastro-enteritis," perhaps he rushed into print using the word "transmissible." He had in mind Goodwin's point that it meant that it was transmitted. There might be different clinical aspects which made it different from the American form, and perhaps it might be preferable to use the word "infectious" at the moment. It was not a question of simple gastro-enteritis in young pigs up to 4 weeks of age. It was an infection which spread right through the herd. Sows were ill for anything up to a fortnight, and in the case of a herd of 60 sows where all the sows went ill within a period of a fortnight, there was something more than a clinical condition affecting the young pig. In his view it was important in those cases to consider swine fever. He found so often that a new syndrome was described in print, and then his colleagues and himself were inundated with queries, "Is this the disease?", forgetting the old stand-by ones, which it usually turned out to be rather than a new one. With transmissible gastro-enteritis troubles, swine fever should always be borne in mind first, second, and last.

With regard to baby-pig disease in gilts, in his view it was often associated with the genetic make-up of the dam. A gilt was still growing herself when she had her first litter; therefore, the new-born started at a disadvantage. It was probable that the feeding of the dam could have bearing on the point whether the piglets would die or survive. Again it would be influenced by the number born. That was why one sometimes saw what appeared to be an infectious condition in a series of gilts. A large number of piglets died within a few days and it looked like an infectious agent whereas, in actual fact, it was probably a question of a number of gilts somewhat immaturely mated to a boar, so that the piglets were born some 24 hours or 12 hours earlier than they should have been. Therefore, there was the possibility of weakly piglets or those whose metabolism was not working properly being farrowed.

As to uraemia, when looking at the thyroid gland sections the opportunity was taken to see if there was anything abnormal with the kidneys histologically but sections gave a varied picture. He did not find any sections which would tie up with uraemic acid infarcts.

The importance of morbidity rather than mortality was a good point. Many times he had thought of that aspect of the quality of sows' milk but had never seen any figures of any chemical analyses done or anything that could show changes in the quality. However, there was undoubtedly a great deal of farming experience which suggested that the milk of certain sows was of better quality than that of others.

In many ways anaemia did not come within the strict terms of the paper. The suggestion about injecting at 3 days old had been made. The author was not altogether struck with the idea. He had taken hundreds of blood samples during that early week of life, and felt that the injection was being made a little too early. Danish experience showed that some strains of piglets started off with higher levels of haemoglobin than average and never reached the anaemic level during the first 3 weeks of life by which time they could then get hold of food. Therefore, it would be useful if more of the money spent on drugs by the farmer could be spent on looking after the sow.

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Lameness in the Forelimb of the Horse

BY

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THE forelimb of the horse is exceptionally prone to injury and disease whether one is comparing it with the hind limb, or with the forelimb of other species. The single digit evolution is a factor contributing to disease susceptibility since there is, below the knee, no sharing of stresses and strains and no collateral support. Evolution for speed has developed length of bone with resulting powerful leverages which may contribute to strains but the most serious cause of trouble in the forelimb is concussion, even though the shock of contact with the ground is absorbed and spread by the application of the limb to the body through an enormous mass of muscle and connective tissue. The fetlock angulation also cushions the same shock, the powerful flexor muscles, aided by the suspensory ligament and the check ligament, taking the strain of the extension of the fetlock joint as the weight of the horse bears down the limb.

Bone Conditions

A categorical statement that concussion is the chief cause of forelimb lameness requires some qualification, especially when discussing bone diseases. Sometimes the qualifications threaten to obscure the original premise, but concussion remains of major importance in most conditions.

Forelimb lameness may be associated with bony enlargements of the knee, with splints, sore shins, osselets, ankle bones, ringbones, sidebones, pedal ostitis, split pasterns and navicular disease. Besides concussion, some of these conditions have been attributed to heredity (the view embodied in the Horse Breeding Acts referring to articular ringbones, sidebones and navicular disease), to faulty conformation, mineral imbalance, vitamin deficiency and working too fast when too young.

Bumbly knees, which comprise bony enlargements of the distal epiphysis of the radius and bursal or fibrous enlargements on the front of the knee itself are associated with rapid growth and development in yearlings and two-year-olds. Improvement occurs most satisfactorily if the animal's metabolic activity can be lowered by restricting exercise and reducing the diet to meadow hay, cut grass and mashes with little corn. A full, reasonable and balanced supply of vitamins and minerals should be supplied.

Osselets and *Ankle bones,* which are bony enlargements of the distal extremities of the cannon bone and os suffraginis occur in young horses under pressure of work. The horses' growth rate and diet may render them more susceptible to these conditions. The main factors are probably youth, conformation and concussion. Treatment consists of a mild blister, which necessitates some rest, or a charge to support the joint. The animal should be given a spell of slow work on soft going. The condition may permanently affect the fetlock region and is often associated with some bursal enlargement. These bursal enlargements also occur in older and overworked horses as windgalls. They may be reduced by rest and the support of a charge.

Sore shins are a condition of diffuse periostitis of the front of the cannon bones. They occur in young horses, usually in two-year-olds, as a result of concussion. There must be a number of contributing factors relating to the animal's growth, diet and fitness. Heavy, well grown two-year-olds are more susceptible to sore shins than lighter animals. Sometimes the disease will descend on a string of young horses like an epidemic, probably because the ground has become hard at a time when the animals' work is being increased. Steady road work during the winter before the two-year-old racing season is one means of avoiding sore shins. This ensures not only small doses of concussion but also that the horses are reasonably fit before they go into fast work in the spring.

Sore shins occur as the result of preparation for racing and the trainers want the animal back in work as soon as possible. Up to the present the position seems to be that the more drastic the treatment, the quicker and more dependable is the cure. The application of a one in ten blister of biniodide of mercury in lard produces a severe reaction and the animal becomes sound and workable in about a fortnight. Meanwhile valuable time and condition have been lost. Milder dressings, such as kaolin or other poultices and liniments based on iodine or belladonna soothe the part and restore soundness of action but as soon as fast work is commenced the sore shins are likely to flare up again. It would be useful if some means could be devised to relieve the pain of this simple condition without having to resort to making it worse to make it better.

Splints are a constant source of annoyance in young horses commencing work and they may be even more troublesome when they cause lameness in older horses. In two-year-olds a strong iodide dressing may effect a cure but one puncture with a fine iron point at red heat under an anaesthetic is the most dependable remedy. These splints usually subside. Splints in older horses can be remarkably persistent and interference may make them larger. Pin firing is again the most satisfactory means of curing the lameness. The complete excision of the splint bone and its associated enlargement has been carried out in some cases of stubborn and persistent lameness but it is not as yet an established practice.

Diseases of the feet. Very little advance seems to have been made in the last half century in the treatment of horses' foot troubles. Ringbones, sidebones and pedal ostitis are still met with and are still treated with tubbing, grooving and stimulants applied to the coronet with the purposes of softening and enlarging the hoof. The more frequent use of radiography for foot diseases has gone a long way to help accuracy in diagnosis. In some cases the firing iron is applied

to reduce the inflamed tissues and is frequently followed by success. Surgical shoeing still has its value and the keenness of the farriers to help and their high standard of work in these special cases is worthy of comment and praise. Quittors and foot cankers are now seldom seen. Antibiotics have helped in these cases, but the main factor in their disappearance is probably related to the high price of horses for slaughter.

Navicular disease is the one disease that can really claim the horse's forelimb as its peculiar realm. No attempt is made to assign a cause to this complaint other than to class it as an arthritis and hope that one day research will reveal the cause and discover a cure for this terrible scourge of men and animals. Concussion seems to play no part in the production of condition. The diagnosis of navicular disease remains difficult and the implications of the disease are so serious that precise diagnosis is important. Differentiation from shoulder lameness, occult splints or other foot diseases such as ringbones, sidebones, pedal ostitis and corns is far from straightforward. Nerve-block and radiography are essential in most cases. The assessment of early changes in the bone and the foramina is difficult and it may be that cases read on X-ray films as incipient navicular disease may never develop the condition. In these cases the lameness that has caused the investigation must have been due to some other cause, not detected, and from which the horse has made a spontaneous recovery. There are times when such cases lead to some embarrassment. The owner's thankfulness that his horse may not, after all, be suffering from navicular disease creates an atmosphere in which recrimination is not likely to develop.

Less fortunate is the owner of the horse in which a positive diagnosis of navicular disease has been established. The disease may develop slowly and can be subject to fluctuations in intensity. The animal pulls out slightly lame and may warm up sound. Special shoeing, hoof grooving, and turning away in marshy ground for 6 months are methods chiefly designed to postpone a final decision and if they prove successful in effecting a recovery they only indicate an incorrect diagnosis in the first place. Preparations of cortisone injected into the navicular bursa have been claimed as successful in some cases. The logical and desperate remedy of un-nerving may be applicable in a few cases after very careful consideration of all the facts. This applies also to other stubborn causes of lameness originating in the foot.

Split pastern. This condition is due to a peculiar and extreme concussion and it would have been claimed as confined to the forelimb had the author not recently met with a case in the hind limb. This accident may involve the cannon bone or either of the pastern bones. The fracture occurs while the horse is galloping and appears to be due to the alignment of the bones in such a way that, as the foot reaches the ground and the limb takes the full weight of the horse, all the lower joints are exactly balanced between flexion and extension. The force of the horse's weight drives down this column of bones and under the thrust the small pastern bone may shatter into 40 or 50 pieces. Such cases are accompanied by an explosive crack which may be heard a hundred yards away. More usually the accident results in a mid-line crack of one of the three bones that may be involved. These milder cases are very painful over the line of fracture since the periosteum remains intact. On radiographs the fractures frequently appear to extend on to the surface of a joint but they usually recover without affecting the normal joint action. It may be that the cartilage lining the joint is not involved in the fracture or its repair. These split pastern or split cannon fractures may happen when the horse has momentarily lost balance and is attempting to recover by propping out a foreleg to one side, but cases do occur in what seems to be normal balanced fast work. The animal should be kept standing for at least 3 weeks to avoid the leverages of getting up and lying down which are liable to extend these injuries from a simple crack to a complicated fracture. Very painful cases may be relieved by injecting a long lasting local anaesthetic and then applying a blister.

Strain

The flexor muscles with their tendons and the supporting ligaments are the tissues most often in trouble in horses that are required to do fast work. Tendon strain frequently results from the efforts of the flexor system to absorb concussion at the fetlock joint. A long sloping pastern is mechanically weak and reduces a horse's racing pace but there is a minimum of concussion and this type of joint is seldom associated with tendon strain. The too upright pastern lends itself readily to jarring and the flexor muscles must make an effort at every step to ease the weight of the animal down on to the extending fetlock joint. Conformation, hard ground and speed (with which age, fitness and tiredness must be considered) are the main contributing factors; the basic cause of many strains being loss of the rhythm of muscular contractions, the flexor muscles becoming fatigued from their effort to take the weight of the horse at each stride. These muscles are making an effort to contract at a time when powerful extending forces are acting. A strain may result from one instantaneous opposition of forces or it may be the accumulated result of repeated small opposing efforts. In the former case the fresh injury is likely to be localised. In the latter the tendons may be diffusely swollen when first noticed and both legs may be affected. It is worthy of comment that some cases of strained tendons may occur without showing lameness at any time. They are taken seriously because experience has shown that if such strains are ignored they will develop into acute cases when put under the pressure of further galloping work.

The suspensory ligament, by itself, is more likely to be torn by a momentary strain but it may also be involved with the tendons when they are severely injured. The check ligament may also be strained without involving other tissues or it may be included in a more diffuse injury. There appears to be little value in distinguishing between strains of the perforans and perforatus tendons. *Post-mortem* examination of a number of recent and of healing

cases have never shown an injury exclusively affecting one tendon.

It has frequently been noted as remarkable that tension in muscle and tendon should cause tearing of the strong tendon tissue without injury to the softer muscular tissues. This apparent resistance to strain may have a simple explanation in the physiology of contracting muscle but it would appear that the freedom from injury is only one of degree since, in a number of cases of strained tendons, definite indications of muscular injury have been detected when an electric current has been passed through the flexor muscles.

Treatment of tendon strain

The choice of treatment of strained flexor tendons and their associated ligaments in the forelimb depends on two main factors: the severity of the injury and the purposes for which the horse may be required in the future.

The severity of a strain in the tendons or ligaments is very difficult to assess. No other injury causes so much worry in racing stables. Every evening the trainer literally looks for trouble by running his fingers down the back of the forelegs of each of the horses in his care and if any heat is detected he knows that immediate treatment must be applied. Minor cases with little heat and no pain or swelling cannot be shrugged off as unimportant. Reducing the horse's corn ration, a saline laxative and a few days off work will restore the leg to normal coolness, but the inflammation will probably reappear on return to the high feeding and hard work necessary to keep the animal in fit condition. Sometimes cooling pastes, lotions and bandages or the cold hose will keep the legs fine and cool. At other times the inflammation persists and resort has to be made to stimulating liniments and blisters.

In more severe cases which may, from the first, include obviously torn tissues with extravasation of fluids, the effects of cooling lotions are not considered adequate and it is recognised that stimulant treatment is necessary to establish a satisfactory repair. This cannot be applied immediately. The first requirement is to limit effusion and soothe and support the injured tissues. Firm bandaging over a layer of cotton wool is probably best for a few days. Hot applications are contra-indicated since they encourage extravasation. The horse is rested and his diet is reduced. The swellings subside naturally and after a period of up to a few weeks the animal may walk and trot sound.

If the horse is to be raced again some further treatment of the leg is required, otherwise the healing tissues are likely to be strained once more on return to work even if a very extended period of rest is allowed. The object of applying stimulant treatment to the leg is to repeat and enhance the process of inflammatory repair so that strong fibrous tissue is laid down in the leg. This is brought about by blistering preparations or by firing under an anaesthetic. Both legs are treated alike, since experience has shown that, if the injured leg only is treated, trouble is likely to develop in the other. Firing probably affects a horse's speed by slightly shortening his stride and for this reason the firing of horses required for racing on the flat is to be avoided if possible. Speed is not of such paramount importance for steeplechasing and firing is frequently demanded for the treatment of injured 'chasers. There seems to be no other treatment so dependable in its results. The beneficial effects of firing appear to depend on the laying down of fibrous repair tissue in the tendons following the extreme and deep inflammatory reaction. The greatest disadvantage of firing is the long period required for the inflammation to subside completely. This is likely to be a matter of 6 months or more but it is hoped that electrical treatment (rhythmical muscular contractions) may prove to be a useful method of shortening this period. Other methods of treating strained tendons are by inductothermy, acid firing, blistering ointments, and by leg paints and liniments innumerable. They all have their successes and are probably effective in proportion to their capacity to shrink away the effusions or to stimulate the deposition of fibrous tissue.

Electrical Treatment of Muscle Injuries

Simple muscle strains usually recover with rest and some assistance from a liniment. There are, however, cases of injury to muscle tissue and to muscle attachments that do not recover readily, and the names given to these conditions—loss of action, jarred shoulders, rheumatism, fibrositis—associate themselves readily with the idea of chronic and persistent lameness. Some of these cases may follow wounds or injuries; in other cases the cause of the lameness is obscure.

Treatment of chronic lameness of the types described above by a form of faradic current have proved successful in many cases that have failed to respond to other methods. A 12-volt car battery is used as the source of electricity since this gives a safe current of small dimensions and the risk of severe and dangerous shock is thereby eliminated. The horse receives a surging interrupted current. A surge is a rapid series of stimuli of increasing intensity commencing at zero. Current applied in this way reduces electrical sensation to a minimum. The speed of the surges and the strength of the current can be varied as required. The actual working current, except for momentary impulses, remains well below a hundred volts and the amperage is only in negligible thousandths. There is no heating effect. This type of treatment is not claimed as new. It has been used in the treatment of human beings for many years. Its application to horses in other than isolated instances is comparatively recent and a special apparatus has been evolved for the particular requirements of the horse.

The indifferent electrode is included in a large pad which is placed on the horse's back over an 18-inch square porous sheet soaked in saline and the whole is kept firmly fixed by a roller. The active electrode is a small pad carried in the operator's hand and it is applied to the area to be treated. This area is first smeared with a tragacanth emulsion which is both a lubricant and a conductor. Rhythmical muscular

contractions occur when the pad reaches or rests on certain spots known as motor points.

The value of this electrical treatment lies in its ability to cause rhythmical contractions in muscles. The operator can select the muscles to be stimulated and can control the strength and the speed of repetition of the contractions. The effect may be lightheartedly described as exercise without effort.

The pain associated with muscle injuries is usually due either to pressure from effusions or to tension due to adhesions. Both these causes of pain are reduced or removed by the rhythmical contraction of the muscles. The circulation in the area treated is so stimulated that effusions, particularly recent effusions, are rapidly and sometimes spectacularly absorbed. The enforced activity of the muscles breaks down and frees many of the painful adhesions. Continued treatment and regular exercise (which is an essential accompaniment of the treatment) maintain an improved circulation and adhesions are prevented from re-forming in inflamed tissues. The electrical stimulus causing rhythmical muscular contractions can deal in this way with pain due to small (and possibly multiple) adhesions. Resistant strong adhesions may sometimes be torn clear by vigorous exercise. In these cases lameness from effusion may follow and this will rapidly respond to treatment applied to stimulate fluid absorption.

The method is, incidentally, of diagnostic value. The muscles are stimulated to contract individually and clear indications are elicited from the horse when contractions are produced in an injured muscle, so that the site of the lesion can often be precisely defined.

This electrical method is not only of value in the treatment of injured muscles. Its effect on the circulation has already been referred to in connexion with the absorption of effusions. This effect is more than local. Stimulation of the muscles of the fore arm can so affect the circulation that effusions and swellings in the lower limb are readily absorbed, and even the comparatively static and organised effusions that follow firing of the tendons are reduced in a much shorter time than would be required without this assistance. The fact that in nearly every case treated by this method exercise can be combined with, and is really an essential part of, the treatment, means that many horses are in full work when they are discharged and consequently in something approaching fit condition for racing. Even the simple muscle injuries that usually recover with rest and the assistance of a liniment need not have suffered the setback that accompanies rest and could in many cases have been kept at work with advantage.

THE SPEAKER'S INTRODUCTION

Dr. A. C. Fraser said that those who had read the paper might have observed that it fell into two sections. The first section dealt with a number of common causes of lameness in the forelimb and was based on the accumulated experience of generations of veterinary surgeons, modified very slightly by his own experience of 30 years of horse practice. Having written the paper, the conclusion he had reached was that the first part was lacking completely in originality and that there was very little opportunity for discussion upon it since there had not been any recent advances in the diagnoses or treatment of most conditions of forelimb lameness in the horse. It was to be hoped that that pessimistic conclusion would be "scotched" during the discussion.

The remainder of the paper was an attempt to introduce something savouring of a little originality, and the concluding paragraphs referred to conditions traceable to muscular pain in the horse and their treatment by electricity.

For a good many years he had been searching for an alternative to the firing iron. It was his ambition to have his irons electro-plated and hung on the wall of his sitting room, but they still remained on active service in his surgery, and he had failed to find a satisfactory substitute.

During his search he had come across the electric treatment referred to in the paper. It had been tried out on some cases of strained tendons, but in most of them it had not proved very useful. However, it had been remarkably effective in the treatment of conditions of pain traceable to muscular injury. During the last 2 years more than 60 cases of chronic lameness had passed through his hands and had been treated by rhythmical muscular contractions with a high proportion of cures. The animals had been discharged sound and most had remained sound in spite of the most rigorous usage.

The electrical method was difficult to explain and so he had prepared a film which would perhaps answer some of the questions that came to mind, such as: Does it do anything to the muscles? Do the horses object to the treatment? What control is necessary?

(The film was then shown. It demonstrated the visible activation of individual muscles and of groups of muscles, and showed that the horses remained quiet or continued to feed while treatments were being given.)

The Opener

Mr. J. S. M. Cosgrove, in opening the discussion, said that there had been no collaboration between the author and himself in connexion with the electrical machine. The paper was most comprehensive and covered many causes of lameness. Any one of the causes might be the subject for a paper and it was somewhat difficult to know just how one should confine one's remarks.

For quite some time they had not been completely fulfilling their obligations in the treatment of athletic patients—race-horses, show horses, show jumpers, ponies, and so on. They had for too long been depending on old-fashioned methods which gave some results but were slow in producing them Owners could not afford to keep race-horses or jumpers laid up in the middle of the season, and credit was due to anybody who introduced treatment that would speed recovery.

A thought which came to mind was whether they were in danger of losing a valuable part of their practices. The medical profession had largely lost contact with athletes in the treatment of strains and injuries that were so common to him. Only recently it had been mentioned that accompanying the English cricket team in Australia was a physiotherapist. Again, one week a footballer would be seen hobbling about and the next week he would be able to play again. If veterinary surgeons applied some of the methods which were used by physiotherapists they would probably shorten the period of convalescence needed by a large number of horses. A physiotherapist depended upon massage and hot and cold applications and a number of electrical treatments, such as "deep" heat, provided by infra-red rays or diathermy. Ultrasonic treatment had taken the field in America.

Faradism, as described by Dr. Fraser, was a treatment that could be competently administered quite easily with no fear of any harm being done. It was a treatment which the animals took to very well. Only the previous week he had been asked to see a yearling that was lame, and which, after treatment with the machine, managed to attract £3,000. But the treatment had its disadvantages in that it was expensive and the average practitioner with a mixed practice would probably be unable to afford to use it. The treatment was also time-absorbing. It might be satisfactory for those dealing exclusively with horses, but not for the general practitioner. Sometimes the treatment lasted for 2 hours per day over a period of 3 weeks.

Was there any other modern treatment that could be applied to give such good results as those obtained by the

machine? There was cortisone therapy, which had come into fashion and gave good results, particularly in the case of muscular conditions. One sometimes saw two-year-olds which had become "jarred up" on hard ground and had lost their action, and their extension was not what it should be. Cortisone had a spectacular effect in such cases in relieving the soreness. Myositis was relieved by it in 3 to 4 days.

In the case of bursal inflammation, he injected cortisone direct into the bursa, and preferred the older type of cortisone for that purpose. Cortisone was not curative in itself—the effect was transitory—but the return of function of the part affected went a long way towards recovery. If it were possible to take away the soreness and to encourage the muscles to play their part again recovery was brought very much nearer. Some people would point out that the use of cortisone would save only about 3 weeks' incapacity, but that might be a vital 3 weeks in the life of a show jumper. When horses had to rest they were losing their owners a lot of money.

The paper mentioned sore shins and blistering. Perhaps pin-firing gave the best results but, again, cortisone injections might enable the horse to recover rapidly. A large number of bone conditions were due to nutritional imbalance. The majority of race-horses were not fed a balanced diet, there being a mineral or vitamin deficiency. That was particularly noticeable in the case of traumatic epiphilsitis or bumbly knees. Many cases of that occurred in young horses grazing on new leys which were heavily manured, particularly in the early spring. The lesion was very obvious upon X-ray examination.

One heard the expression "A flush of grass in the spring." It seemed likely that the artificial manures were locking up an important mineral or vitamin which was prevented from being absorbed into the system. It might be a trace element or calcium or phosphorous. The author mentioned that his treatment for bumbly knees was to cut down the diet: he himself acted in the opposite way and increased the diet. He varied the cereal and instead of feeding oats by themselves, supplemented them with a skimmed milk powder and a mineral or vitamin preparation. The animal's exercise was restricted; it was taken off new leys, and when it went back to pasture it was put on old pasture. It was a mistake to cut down on nutriments. To take away protein did not obtain the best result in the end. If reductions were made early in an animal's growth it would have to be paid for in the long run.

One might have expected that in the present year fractures would not have been numerous, but in fact they had been extremely numerous in Ireland and there were a large number of split pasterns. In the treatment of a split pastern it was necessary to get the animal off its feet, and it should be put down on a firm bedding of sawdust and peat. There would then be no trouble when the animal got up and down; it was surprising how an animal would balance itself without putting weight on an injured leg.

The Reply

Dr. Fraser, in reply, said that he had been most interested in the discussion. Mr. Cosgrove's main contribution to the subject was his great experience of and his report on the use of cortisone. With regard to dietetics, he agreed with Mr. Cosgrove's observations. Horse dietetics were lagging far behind those of other animals, the chief reason being the difficulty of assessing horse productivity.

It was true to say that corns were a most important subject in connexion with troubles of the foot. Corns were a common cause of lameness and their incidence was not always easy to determine.

Mr. Sumner's remarks regarding the chipped bone were most interesting. The importance of adequate drainage from wounds could not be over-emphasised.

The maximum voltage of the electrical machine, with a horse in the circuit, was 120; without a horse in the circuit it was 280. Sixty volts was the highest current the horse was likely to receive, and usually it was about 20 volts. There was no risk involved. A notable point about the electrical machine was that contractions could be obtained in individual muscles. The response was greater when one reached the spot where the injury existed so that diagnosis could be very precise. Mr. Cosgrove's point about the economic importance of saving time was very valid.

If he had been asked to produce a paper on lameness below the fetlock, as Mr. Shuttleworth had wished, he would have found the task very difficult, although he agreed that many of the most puzzling and consequently the most interesting cases of lameness derived from this area.

The Responsibilities of the Veterinary Surgeon

BY

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Introduction

A VETERINARY surgeon is a responsible man as a member of the community and also a member of a profession with a statutory registration. It is those responsibilities arising particularly from the latter with which I wish to deal to-day.

His responsibilities, or duties, may be grouped under three headings:—

A duty to the State,

A duty to animals, and

A duty to other human beings, such as fellow practitioners, clients and the general public.

Some of the above duties and responsibilities are dictated by law, some by the professional code of ethics, and some by conscience and general good behaviour. It is not difficult for me, as a lawyer, to interpret the legal responsibilities and duties of the veterinary surgeon, and, as a reasonable average man, I may be allowed to pass some opinion on the general conscience and behaviour of a veterinary surgeon in his private capacity as a member of the community. In the realm of professional conduct and ethics, however, I step with some trepidation and have not gone beyond that laid down by the profession's governing body, the Royal College of Veterinary Surgeons.

Strict law in itself is rarely sufficient to define duties and responsibilities, and where strict law is enlarged by a code of professional conduct, I have sought guidance from discussion with members of the Royal College, of the British Veterinary Association, and particularly am I indebted to that very useful publication issued by the Royal College of Veterinary Surgeons in May, 1951, entitled "Guide to Professional Conduct."

Whilst on the subject of acknowledgments, I should like, particularly, to mention the assistance I have received from Dr. J. K. Walley, PH.D., B.V.SC., M.R.C.V.S., F.R.I.C., treasurer of the National Veterinary Benevolent and Mutual Defence Society. Dr. Walley has enabled me, as a layman, to understand something of the veterinary surgeon's method of life and practice and, by making available to me, in confidence and with names and references suitably deleted, a selected digest of claims on the Veterinary Defence Society, he has enabled me to realise the type of legal problem which arises in day-to-day veterinary practice.

Let us now take the three divisions of duty in order; that is, duty to the State, to animals, and to other persons and, begin with the veterinary surgeon's duty to the State.

Duty to the State

The duty a veterinary surgeon owes, as such, to the State is set out in various Acts of Parliament, under all of which he should know and realise his responsibilities. An Act of Parliament and regulations made thereunder should leave no room for doubt, and define the conduct a person must exercise in order to discharge his part as a member of the community. Probably that Act of Parliament which lays upon a veterinary surgeon most strongly his responsibilities and duties is the Veterinary Surgeons Act, 1948.

I do not intend to go through this Act in detail, but would direct your attention particularly to Sections 14 to 17 because here the State has delegated from itself to the Royal College its power to regulate the profession. In spite of this delegation, however, under Sections 14 to 17, the State has reserved to itself an overriding duty in that appeals are allowable under Section 18. Section 18, you may recall, reads as follows:—

> "1. Any person aggrieved by the removal of his name from the Register of Veterinary Surgeons by the suspension of the effect of his registration in that Register, or by the period of any such suspension, or by refusal to restore his name to that Register, may in accordance with rules of Court, appeal to the High Court.
>
> "2. On any such appeal the Court may give such directions in the matter as they think proper and any Order of the Court under this Section shall be final."

That this is a very real reservation is borne out by the decision and dicta in the case of Allender versus the Royal College of Veterinary Surgeons decided in 1951.[1] I quote from the Judge's statement:—

> "The Court will naturally pay the greatest attention to the decision which has been given by the Council of the College but it will not prevent them in a case where they think that the decision below was not justified on the facts from reversing the decision of the Council."

Another instance where a duty to the State overrides what may be a professional or private opinion is the Animal Anaesthetics Act, 1919, where covering the question of de-horning the duty to the animal was transferred to the State which lays down precise rules of conduct.

All veterinary surgeons must, of course, be familiar with the Diseases of Animals Act, 1950, where a large number of duties owed by the veterinary surgeon to the Ministry of Agriculture and Fisheries as representing the State are laid down and must be complied with. This Act is of great

importance to the practising veterinary surgeon and a very good digest on it has been prepared by a Mr. L. Thomas, designed for the non-lawyer, under the title of "Diseases of Animal Law" published in 1951, price 2s. 6d. Furthermore, all veterinary surgeons should have, in their possession, the Handbook of Orders relating to Diseases of Animals, published also in 1951. Again, the Docking and Nicking of Horses Act, 1949, lays down precise rules by the State for the conduct of veterinary surgeons, and no doubt many of you can think of other Acts and Orders which regulate your mode of professional conduct.

Your duty to the State, however, in relation to your professional standing, goes further than mere acts of professional practice because you may be struck off the Register of Veterinary Surgeons if you commit a misdemeanour or felony, whether that misdemeanour or felony is directly related to practice or not. The basis for this is that as a member of a profession with regulated privileges, rights, and duties, your conduct must be such as to justify your inclusion in that profession and if you commit a misdemeanour or felony, there is a strong suggestion that your character is such as not to entitle you to remain a member of an honourable profession.

As far as summary offences are concerned, they do not rank so highly for consideration of erasure, but if the summary offence is of a nature to be considered disgraceful, it may call for the erasure of your name from the Register.

As a professional man and an expert in your own field you may be called upon from time to time to assist in the administration of justice by giving evidence in a court of law as an expert. You should remember always that your opinion must be fair and unbiased, whether the person involved is your client or not, and I cannot do better than repeat paragraph 3 on page 24 of the "Guide to Professional Conduct" which states:—

> "*Evidence*
>
> Practitioners, by reason of their professional status, may be called upon to give evidence in Law Courts. Such evidence must always be given fairly and with the paramount intention that justice shall be done. A practitioner who is called by one party to an action to give evidence, is not giving evidence on behalf of that party but as a professional man on behalf of the Court. No practitioner shall fail to give any information in his possession which may be relevant to the matter before the Court."

Furthermore, the veterinary surgeon has a duty to the State, through the Royal College, to help in observance of the code of conduct and the high standing of the profession because paragraph 4 on page 24 of the "Guide to Professional Conduct" states:—

> "*Veterinary Surgeons Acts, 1881-1948*
>
> It is the duty of every practitioner to report to the Council any breach of the Veterinary Surgeons Acts, 1881-1948, which may come to his attention whether the person concerned be registered on any Register under the Acts, or whether such person be a lay person."

The veterinary surgeon may add, voluntarily by his own actions, to the duty he undertakes to the State by assuming additional duties or appointments such as meat inspection under the Food and Drugs Act, 1955. If he issues prescriptions for poisons and dangerous drugs he must, of necessity, observe the Government's code of law for dealing with these.

Duty to Animals

Secondly, we come to the duty owed by the veterinary surgeon to animals. Although this responsibility or duty can be expressed quite shortly, perhaps it should have been dealt with first as it is naturally the overriding reason for the existence of the veterinary surgeon. His duty, in fact, his main purpose of professional existence, is to relieve the pain and suffering of animals, to cure their diseases, and to ensure, as far as possible, their good health. There is, therefore, a strong and legal moral responsibility upon the veterinary surgeon to use his best skill and attention to relieve pain and suffering with animals, by treating them wherever possible. The Protection of Animals Act does, of course, reinforce the duty to avoid all unnecessary pain and suffering.

Duty to Third Parties

We now come to the third responsibility or duty of the veterinary surgeon, and it is in this field that most can be said. The law has, perhaps, the greatest part to play as the interpretations of the duty and responsibilities can vary so very much. The subject can best be dealt with by sub-dividing this duty to other persons into three classes:—

The duty to other veterinary surgeons and employees,
The duty to clients, and
The duty to the general public.

(i) Other Veterinary Surgeons

(a) *Defamation*

The law, as such, does not have a great deal to say about a veterinary surgeon's duty to other surgeons. The law of defamation embracing libel and slander, does, of course, prevent irresponsible statements, both verbal and written, being circulated to the detriment of professional colleagues. Defamation can, of course, be committed by a veterinary surgeon's employee such as a dispenser or a kennel-maid and, in fact, instances are not unknown. Under the doctrine of master and servant, with which I shall deal shortly, the acts of the employee are in this case, in law, the acts of the employer. Defamation is divided into two classes: libel, which is written or permanent, and slander, which is spoken or transient.

Defamation has been defined by one of our leading jurists: "Defamation is the publication of a statement which tends to lower a person in the

estimation of right-thinking members of society generally or which tends to make them shun or avoid that person." It has also been defined as any statement which tends to bring a person into hatred, ridicule, or contempt. Libel is actionable *per se* without proof of damage, whereas in the case of slander special damage must be proved apart from a few exceptions, one of which is imputation of unfitness, dishonesty, or incompetence in any office, profession, calling, trade or business, held or carried on by the plaintiff at the time when the slander was published.

There are various technical defences for defamation, the details of which we cannot deal with to-day, but generally speaking damages cannot be recovered for defamation which is true because the essence of the cause for damages is lowering of reputation; and if the defamation be true, the reputation did not exist to be lowered. It is not thought for a moment that one veterinary surgeon would make disparaging comments about the abilities of a professional colleague, but he should also take care that nothing of this nature is done by his employee, as a short while ago, a veterinary surgeon was threatened with an action for defamation because his dispenser spoke recklessly to clients in the surgery about another surgeon in the district.

One aspect of the law of defamation with which the veterinary surgeon may come into contact in relation to his fellow veterinary surgeons is in the matter of testimonials when a qualified employee is perhaps seeking employment elsewhere and requests a testimonial as to his ability and general conduct. The general opinion is that testimonials are worthless because, being fairly open documents, most employers will take great care what they write because of the existence of the law of libel. In any case no employee is going to submit a copy of a testimonial which is damaging to himself. It would be an advantage if employers would cease to ask for testimonials and thus put an end to what is in some ways an unsatisfactory practice. It would be better were they always to enquire direct of persons whose names were given as references. Similarly, it would be desirable if employers ceased to give open testimonials and offered, instead, to provide references direct to other employers. There is no compulsion at law to pass an opinion one way or the other, when asked, but if one does give either a testimonial or write a specific reply in answer to an enquiry from a prospective employer, there are certain points one should be aware of. Comment on an employee has qualified privilege. In other words it is protected against an action for defamation provided that the person who writes the opinion has a duty to inform the recipient and the recipient has a definite interest in the subject matter. It may fairly be assumed that statements made about past employees and sent on request to a prospective employer are of interest to both parties and will possess qualified privilege. On the other hand, it should be borne in mind that qualified privilege can be destroyed by proof of malice.

Sometimes the veterinary surgeon is placed in an embarrassing position when clients insist on discussing his professional colleagues, and in these cases the veterinary surgeon should always be circumspect. Professional ethics apart, there is always a risk of committing defamation and note should be taken of a further tort known as slander of title or injurious falsehood. Slander of title is a false and malicious statement about a person, his property, or profession, which damages, not necessarily his personal reputation, but his business professional and material interests. The words, malice, and malicious, as used, are given in the sense of their legal meaning, *i.e.* done purposely or with intent and not in the meaning generally understood by the public as being spiteful or mean.

(b) *Professional Relations*

As befits a profession of high standing, the Royal College has in its "Guide to Professional Conduct" laid down clearly the tenets of behaviour which should govern relations between members of the profession, and I cannot do better than bring to your attention suitable extracts from the "Guide." The views of the Royal College in full are set out on pages 15 to 18, but note particularly the following:—

> "Every practitioner is under an obligation to promote the interests, honour and dignity of the veterinary profession. The professional relations between practitioners must be based on such honour, good faith, and mutual trust."

The question of mutual trust and fair dealing is particularly borne out by the Royal College's ruling on the position of assistants. I quote:—

> "An assistant, whether required to sign a bond or not, is bound in honour not to set up in practice for himself in the district covered by the practice of his former employer except with his consent, which should be in writing and expressed in clearly defined terms. It therefore follows that an assistant who does so engage in practice without such consent before a reasonable lapse of time may be deemed guilty of conduct disgraceful in a professional respect."

I stated earlier, under the heading of the duties of the veterinary surgeon to animals, his responsibility to treat whenever necessary and this is reinforced by the views of the Royal College on the relations between veterinary surgeons where mutual aid is concerned. The Royal College states:—

> "A practitioner may be called in by the owner of an animal to attend to an urgent case of accident or illness when, for some unavoidable cause, the practitioner usually in attendance, cannot attend. In such circumstances the practitioner called in must do what is immediately necessary and no more. He must at once inform the practitioner concerned of the action he has taken. He

should consider that he is acting on behalf of his colleague and take no further action in the case except at his request."

I think all veterinary surgeons should particularly note the words there and I quote again "He should consider that he is acting on behalf of his colleague. . . ." Furthermore, the Royal College has attempted to regulate what might be undignified scrambling for clients and unprofessional competition because they rule and again I quote:—

> "If a practitioner is called upon by an owner to see a sick animal which is, or has recently been, in the care of another practitioner, he should decline to attend, except either as a consultant or unless the first practitioner has retired from the case, or has been informed by the owner that his services are no longer required. The practitioner called in should also inform the practitioner whom he is superseding."

(c) *Master and Servant*

And now the question of master and servant. The meaning of servant is not restricted to that ordinarily understood, that is a servant in the domestic sense, but it is a legal term applied to any employee who must carry out the day-to-day orders of his employer as distinct from the independent contractor such as a builder or decorator who arranges to do a job and is left free to decide how to do it. A veterinary surgeon acting as an assistant to another veterinary surgeon is in law a servant and his actions are governed by the law of master and servant in spite of any professional relationship which may exist. The master is responsible for any wrongful acts committed by the servant while in his employment provided the acts might be accepted to be part of the employment. If an assistant is negligent in his treatment of an animal, the person whose animal is damaged may sue either the veterinary surgeon, the assistant, or both, as it is part of the assistant's duty to attend the needs of clients' animals and to treat them. If, however, on his way home, the assistant carelessly runs over somebody with his car and causes damage, this is not a liability to the veterinary surgeon as it is not in the ordinary course of the assistant's employment. There is, therefore, a two-way responsibility which the law imposes over and above the professional relationship. The employing veterinary surgeon is responsible for all acts committed by his employee in and about his business and should, therefore, ensure that his conduct is such as would be that of himself. While the employed veterinary surgeon should realise that any of his acts are not merely his own responsibility but can involve his employer also in legal liability.

(ii) To his Clients

(a) *Standard of Care*

We now come to that field of responsibility in which most disputes may arise: that is, the responsibility of the veterinary surgeon to his client. The veterinary surgeon has a duty to show to his client in the treatment of his animals the reasonable standard of care of the average qualified man. "Reasonable" has almost become a term of art in the law, but what it really means is the average standard of behaviour by a person judged against members of a similar class or profession. Therefore, the veterinary surgeon in practice is expected to give a standard of care, treatment and attention that would be given by the average veterinary surgeon throughout the country, and this would always be a question of fact to be decided on evidence given before the Court. A veterinary surgeon is not expected to be exceptionally qualified and to have the knowledge and experience of an admitted leader in the profession. Conversely, he must not show a standard of care or hygiene lower than would be found in surgeries throughout the country; and if evidence were brought from other veterinary surgeons to show that the profession considered he was giving less than the normal care, he would not have acted "reasonably."

A veterinary surgeon is not responsible for normal errors in judgment that cannot be legislated against because diagnosis can never be certain. It is his responsibility only to diagnose and treat to the best of his ability. The fact that he is qualified and on the Register is proof in itself that he has attained a reasonable standard of knowledge with which to practice his profession, nor would he be responsible if a cure were not effected because, like his professional colleague, the doctor, he cannot guarantee to cure disease. He should, nevertheless, in his relations with his clients, be careful to avoid the suggestion of guaranteeing a cure. A professional man is not expected to puff his ability as a tradesman would the wares in his shop.

He is not expected to have a deep knowledge of, or to use, all the latest discoveries. Whereas he is not expected to use treatment and methods which are condemned or which have been abandoned by the profession in general, no liability would attach to him if an animal were lost because he had not employed a treatment or a drug so new that these were not in general use by the profession. If the veterinary surgeon departs from this degree of care he lays himself open to an action at tort for negligence. As early as the fifteenth century, writing about the duties of a professional man, one of the leading lawyers of those days stated:—

> "It is the duty of every artificer to exercise his art rightly and truly as he ought."[3]

In modern times the definition is:—

> "Negligence as a tort is the breach of a legal duty to take care which results in damage undesired by the defendant to the plaintiff."[4]

You should note that although it is only breach of a legal duty which gives rise to an action, there is no doubt whatsoever that in the relationship between the veterinary surgeon and his client, a legal duty of care always exists. No veterinary

surgeon would be deliberately careless, but in the pressure of practice a slip could occur and it is immaterial whether the harm resulting is desired or even foreseen. All that it is necessary for the plaintiff to prove is that harm to his animal was the result of treatment or lack of treatment from the veterinary surgeon of a standard less than normal. The House of Lords in recent times had laid down a definition of the duty to take care which has, in the past few years, become the legal standard. Lord Atkin said:—

> "You must take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure your neighbour. Who then in law is my neighbour? The answer seems to be persons who are so closely affected by an act that I ought reasonably to have them in contemplation as being so affected when I am directing my mind to the acts or omissions which are called in question."[5]

Few cases involving veterinary surgeons have reached the courts, but many cases have been heard during the last few years calling into question the professional standard of care given by the medical profession and the same principles would apply to the veterinary profession. In Roe *versus* the Ministry of Health, 1954, the Court stated:—

> "The surgeon must exercise such care as accords with the general and approved practice in the profession but he is not an insurer against every accidental slip. The test is the standard of knowledge at the relevant time."[6]

Although few cases have reached the courts involving veterinary surgeons, it is indeed a fact that many claims are made against them, most of which have been settled or disposed of by the Mutual Defence Society. For example, in one instance five pigs were castrated and the first three died of tetanus. It was alleged that the veterinary surgeon was negligent in not taking preventive steps after occurrence of the first death and a settlement had to be made. The second case concerned a pedigree Ayrshire where it was shown by expert evidence that had pregnancy been diagnosed, which the veterinary surgeon should normally have done, expression of corpus would not have been necessary. A cash settlement had to be made to avoid an action that surely would have gone against the veterinary surgeon.

At law negligent mis-statements are not actionable, but they become actionable when there is a contractual relationship between the parties concerned. It is known that there is always at law a contractual relationship between the veterinary surgeon and his client, and therefore a veterinary surgeon must avoid negligence not only in his actions but also in his statements when dealing with his clients.

I have pointed out that the degree of care and attention required from the veterinary surgeon is only that of the average or reasonable veterinary surgeon and two cases defended by the Mutual Defence Society where claims were not successful and were abandoned illustrate this point. The first was a claim for £200 for a bull which died under chloroform. Death under an anaesthetic is a risk that may arise at any time, and as it was shown that the veterinary surgeon used accepted methods of practice and was in no way negligent, the claim could not be substantiated and was withdrawn. The other claim was for undue losses in anaemic piglets where the stock owner said the losses had occurred because the veterinary surgeon had prescribed anaemia capsules instead of iron copper mixture. This claim also could not be substantiated because the veterinary surgeon was treating according to the best of his ability and it could not be said that he was negligent or had tried out some unknown method which gave rise to the losses.

When an owner places an animal in the care of a veterinary surgeon the responsibility mainly passes from the owner to the veterinary surgeon. The owner is no longer entitled to dictate methods of treatment or the drugs to be prescribed, nor will a cause for action lie if the result of the treatment is not as successful as the owner thought possible if he had taken a hand in it himself. Unfortunately, no matter how careful a veterinary surgeon may be in his actions and statements, there is always the type of person who will ever endeavour to recoup himself for inevitable losses by threatening to bring a legal action. The veterinary surgeon who has not been negligent, however, need have little fear of such threats as it is rarely, if ever, that claims of this nature would be pushed as far as a Court action.

(b) *Titles*

Arising from my comments on the standard of care of the profession as a whole and negligent mis-statements, I think I should say a few words about degrees and diplomas. At law no member of a profession should claim for himself degrees or diplomas that he does not possess nor try to enhance in a fanciful manner those diplomas which he has in fact gained. This is reinforced even more so on the professional side by the "Guide to Professional Conduct" published by the Royal College. The Royal College forbids any practitioner, in the exercise of his profession, or in connexion with his professional status, from using, whether in the form of abbreviations, initials, or otherwise, any degree, qualification, title or description, unless it has been entered by the Registrar of the Royal College in the appropriate Registers. Furthermore, members of the profession should not use such titles as F.Z.S., Fellow of the Royal Society of Medicine, or Member of the British Veterinary Association, because the membership of such bodies does not imply a professional qualification. The Royal College makes it clear that not only is it a legal offence but it is a disciplinary offence if any veterinary surgeon uses a description in connexion with his profession which gives the impression that he or any person acting for him possesses veterinary qualifications which, in fact, they do not possess.

(c) *Trespass*

A legal responsibility that the veterinary surgeon may encounter in his day-to-day practice is the need to avoid trespass, particularly trespass to goods. Trespass to goods is defined as wrongful interference with the possession of them and in the case of a veterinary surgeon, usually takes the form of allegations that he has injured or destroyed the animals of a client. In law all that is necessary is to show that direct harm should be done to the goods and it is probably unnecessary for actual physical contact to take place. Originally, at English law, it was a fact that a trespasser to goods of another was liable whether his act was intentional or merely negligent; but to-day it is doubtful whether mere negligence would give rise to an action for trespass. Pecuniary damages can be claimed in cases of trespass irrespective of the amount of actual damage sustained as a method of showing the Court's disapproval of this tort, whereas in cases of negligence in theory the legal damages are based on an assessment of the actual damage suffered. It is very easy for the veterinary surgeon to commit trespass against a client's animals without realising that he is doing so, and undertaking what he thinks is the best form of treatment and that which his professional conscience dictates. For example, in one case a dog was brought to a veterinary surgeon for removal of a toe and inadvertently the wrong toe was removed. The client claimed in trespass. In another instance a horse was being treated by a veterinary surgeon and, through no fault of his, the horse died. That would have been a normal occurrence but subsequently, and without the authority of the owner of the horse, the carcase was sent to a knacker's yard and the owner maintained it was not the man he would have chosen, adding that a sum of several pounds less than he had expected had been received. This was trespass because it was unjustifiable interference with the owner's possession of the horse and the veterinary surgeon had to make up the difference between the sum actually received and that which the owner thought he should have received.

A more serious instance of trespass was when a kitten was brought to a small-animal practitioner for castration and was destroyed in error. The kitten was of little real value but the client complained that a trespass had caused great emotional upset and a sum had to be paid out of all proportion to the true value of the goods trespassed against. There is no doubt that the veterinary surgeon runs a considerable legal risk when dealing with other people's animals in that the law guards jealously a person's rights in his goods. It is important that the veterinary surgeon should obtain clear instructions from the owner and clear permission to do anything that might be construed in law as a trespass.

For many years I have maintained that the veterinary surgeon should insist always on an operation consent form in the same way that the medical profession does. A simple form whereby the owner signifies his consent to the surgical operation upon the animal and, this is quite important, such further alternative operative measures as may be found to be necessary during the course of such operation, would prevent many unfounded claims and much misunderstanding between veterinary surgeons and clients. No doctor or hospital would operate on a human being without a consent form and I consider it is just as important for the veterinary surgeon to have the same protection. Similarly, those veterinary surgeons who keep kennels should have a simple form embodying a disclaimer of responsibility to be signed by persons leaving dogs with them.

The foregoing represent the main responsibilities or duties of the veterinary surgeon to his client at law. There are others of a minor character but it is, of course, impossible in the scope of a paper like this to go into them in full detail.

(iii) To the General Public

(a) *General*

Lastly, we come to the veterinary surgeon's responsibility to the general public. He has, of course, a responsibility as a member of the community, as we all have, to live at peace with our neighbours and observe the customs and laws of the country. We are concerned to-day with responsibilities that arise particularly from his being a veterinary surgeon, and there I think it will be sufficient if we outline two aspects—nuisance, and third party liability.

(b) *Nuisance*

Nuisance is an unlawful interference with a person's use or enjoyment of land or of some right over or in connexion with it. The nuisance may be public which is a common nuisance affecting the public generally and may be prosecuted as a crime only with the permission of the Attorney General, or it may be a private nuisance which injures a private person or persons exclusively. It is the private nuisance with which the veterinary surgeon sometimes finds himself involved.

Some veterinary surgeons maintain boarding kennels, and occasionally neighbours lay a complaint that a nuisance is being committed and threaten the veterinary surgeon with legal action. Whether a nuisance is or is not committed is in all cases a matter of fact to be decided upon the circumstances existing at the time, and it is impossible for any general rule to be laid down. Degree of nuisance will vary with the district, the type of building, and the particular nuisance complained of, and any veterinary surgeon threatened with a civil action for nuisance should consult a local solicitor well acquainted with the conditions and act on his advice. Some areas have by-laws which prohibit a nuisance of the type made by noisy animals or by keeping animals in numbers in a residential neighbourhood and in those cases the local council, on complaint from private residents, may institute proceedings in the magistrates' court. No general rules can be laid down for this as the circumstances would depend on the wording of the particular by-law and on local conditions, and legal

advice should be sought locally always if disputes arise. The very essence of nuisance is interference with enjoyment of property and one of the main tests is that of reasonableness, although unfortunately no legal definition of "reasonable" exists, and even use of the word has been queried by the Lord Chief Justice in recent judgments. The court, in considering whether a nuisance exists or not, always takes into consideration whether the complaint is reasonable and supersensitivity on the part of the complainants is not sufficient to justify any charge made. The fact that boarding kennels have existed in the district for a number of years without complaint and that at any time the alleged nuisance is not more than that which has been common for a period, is often a sufficient defence.

(c) *Negligence*

And now, to conclude with the legal obligations of the veterinary surgeon to third parties. It is possible for damage to arise to persons other than his immediate clients through actions carried out during the course of his profession. In one instance a veterinary surgeon was destroying a dog with a humane killer and unfortunately the bullet hit and injured a bystander. No doubt, the bystander would expect to obtain damages from the veterinary surgeon, whose liability would be decided on a question of accident or possible negligence. Probably, if all reasonable precautions were taken when the humane killer was used, no liability would arise: at the end of the nineteenth century a case was decided where a member of a shooting party fired at a pheasant but the missile struck the bough of a tree and then wounded an onlooker who was in the neighbourhood. Although the person injured sued the one who fired the shot, the latter was held not liable because there was no negligence shown and the harm occasioned was entirely accidental and beyond the control of the average man.[7] This nineteenth century case was confirmed as recently as 1951 in the Court of Appeal in a similar type of case.[8]

If, however, negligence can be shown then the veterinary surgeon is responsible to third party. For example, in one instance a dog was boarded with a veterinary surgeon and during the time it was in his care it escaped. While free, the dog knocked a child off a bicycle and this was the immediate cause of a subsequent car crash. The veterinary surgeon was held liable to several third parties: the child on the bicycle, and all those involved in the car crash, as the damage had clearly resulted from the negligent act of the veterinary surgeon in permitting the dog boarded with him to escape.

Often a farm hand, or someone employed by a stockman or farmer, will be asked to assist the veterinary surgeon when treating animals or administering an anaesthetic. He may be asked to help secure them. In such cases the veterinary surgeon should give clear instructions to the person assisting him as he is carrying out professional work which is his clear responsibility. If the third party be damaged during the course of rendering such assistance, there is little doubt but that the veterinary surgeon would be liable. In one claim made on the National Veterinary Mutual Defence Society, which arose out of a de-horning incident, assistance was offered to the veterinary surgeon and the person offering assistance stated he had assisted in this operation before and knew how to hold the animal concerned. The veterinary surgeon, however, with due precaution, refused to accept this statement and gave the most clear instructions as to how the assistance should be rendered. Through nobody's fault the animal kicked out and injured the person rendering assistance, but because of the wisdom of the veterinary surgeon, no legal claim lay against him.

Conclusion

From the foregoing list of responsibilities and duties which must necessarily be an abridged one, it might be thought that the veterinary surgeon is carrying an undue and a heavy burden and some of you may even be frightened to go out and practice, following this Congress. Everything should, however, be considered in due perspective and although there is no doubt that the veterinary surgeon, as a professional man with a recognised status in the community, has considerable duties and responsibilities, provided he acts with care and attention and observes the simple and clear ethical rules of conduct laid down by his professional governing body, together with the wise precaution of either taking out liability insurance or joining a mutual defence society, he need have no qualms and his professional life should be free from trouble.

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THE SPEAKER'S INTRODUCTION

Mr. C. C. Stevens said that the subject of the legal responsibility as distinct from the general responsibility which he had attempted to portray (the legal was an important and a large part of it) had been much more fully discussed both at meetings and in papers, and in the professional press in the United States than in the United Kingdom. One might expect that because the Americans were perhaps more litigation conscious. For example, in the medical sphere there were something like 20 times as many malpractice suits in the United States, even allowing for the difference in the size of the country, as there were in Britain. However, one should not think that because little was heard in public about negligence, malpractice, misfeasance, and so on that the veterinary profession in this country was entirely free from it.

The opener of the discussion was Dr. Walley who knew only too well the legal snags which could arise in day-to-day practice, and if one could see the overall picture, it would be realised that it was not negligible.

In the paper there were quite wide quotations from the

"Guide to Professional Conduct," the hand-book published by the governing body, the Royal College of Veterinary Surgeons. He had read that Guide, not as a veterinary surgeon but as a lawyer, and therefore any remarks made on it in the paper were made as a lawyer, and the deductions drawn were those that one would fairly expect the Court to try if any dispute arose. It was not possible to deal with all the law that affected the veterinary surgeon. It was a great field, because all the law of the country affected him. In addition, at college or university something was learned of specialised law which particularly affected the professional activities of the veterinary surgeon. He had endeavoured to highlight the main factors which affected the veterinarian, and to point out how sometimes law and ethics, conscience and duty became interwoven. Some of the material had appeared in THE VETERINARY RECORD, and he had spoken on purely legal aspects at divisional meetings in an informal atmosphere.

He had pointed out the 3 main duties—to the State, to animals, and to human beings. The paragraph dealing with duty to animals was very short because the law on that matter was very short. There was not a great deal of law mainly because animals, being dumb creatures, were not in a position to bring legal actions to enforce their rights. But because that paragraph was short, he did not desire the reader to dismiss that duty as a minor one. After all, that duty was the whole basis of the existence of the veterinary surgeon and of the historical growth of his profession. Therefore, it was most important.

The duty to third parties was that which brought the veterinarian into legal relationship most of all. That was where trouble could arise, but with other veterinary surgeons, very rarely. The law was to be considered with professional ethics and professional conduct, and in their relations with other members of the profession, veterinary surgeons would of course be guided more by the rules of the Royal College and the dictates of decency and professional good-will than by strict law.

In the matter of professional relations, after he had written the paper and was reading material on veterinary practice and veterinary politics, he was interested to find how some members were still not quite sure of what control the Royal College could exercise. The Royal College was constituted by Royal Charter. There were actually a series of Royal Charters, 8 in all. He had had an opportunity of studying them thanks to the great help and co-operation received from Mr. Oates, the Registrar, and it had to be remembered that if there were no Royal Charter, there would be no Royal College.

It might be useful to indicate the legal position of a body incorporated by Royal Charter. There were various types at law of incorporated bodies in this country, the main type usually being the commercial limited company. Such a limited company had a Memorandum and Articles of Association, and it could only do such things as were set out in the Memorandum and Articles. Anything else was beyond its power, was *ultra vires* and illegal. A society incorporated by Royal Charter might do anything irrespective of the powers and aims laid down in the Charter, and such acts had legal power; but if any body incorporated by Royal Charter went beyond its powers, the Charter might be revoked. If the Royal College were to go beyond its powers or bounds, it would stand in danger of being automatically dissolved.

Recently there had been discussion on the question of fees—members crying out to the College to fix fees, instead of in a professional manner, getting together and reaching general agreement. The Royal College could enforce fees in theory by saying it would be unethical conduct and a member might be struck off if he went beyond the fees fixed by the Royal College, but it was generally conceded that if an appeal were taken to the High Court—and it could be taken to the High Court—no judge would enforce such a restriction on the professional freedom of a veterinary surgeon. If the College were to try to enforce it under its Charter, it was doubtful whether the Charter in its original objects included such a wide definition of powers.

To give an illustration, a professional body of a similar type to that of the veterinary profession, incorporated by Royal Charter, in 1919 endeavoured to fix the fees and remuneration of its members to avoid what was said to be price cutting. One of the members felt that that was beyond the objects of the Charter, and he sought an injunction in the Chancery Division. That injunction was granted and the Society was barred from interfering with purely financial matters of that nature. It was in the days before general disciplinary procedure was common, but it showed that members of the profession could not expect such action from those who governed them.

The paper referred to the legal liability of the veterinary surgeon, and his professional duty to the general public and to his clients. There, of course, was a vast field of litigation. It applied possibly less in the case of the general public than to clients, because it was the clients who had a contract with the veterinary surgeon. Relations with the general public, although less at law, were from the point of view of professional obligation very high, because the profession was judged not by what the law protected and gave to it, but by what the public thought of it and how it judged each individual member of it.

The Opener

Dr. J. K. Walley said that he felt sure it would be the wish of everyone present that he should first of all thank Mr. Stevens for an excellent paper.

The author had mentioned the question of fees and the regulation of practice. It was of great interest to find that even in the days of Babylon in 2200 B.C. there was a Code which regulated fees for work and had harsh treatment for malpractice. Also, the Welshmen present would be gratified to learn that in A.D. 900 the Welsh had a system of warranty for animals which included the fact that the examiner had to guarantee that they were free from fluke and the rest of it!

The author had referred to a large number of Acts, Orders, and statutory regulations. It should be emphasised that it was the duty of all veterinarians to keep their hand-book of Acts and Orders up to date all the time. Each member probably received a piece of paper amending an Act or an Order from the Ministry, and he probably put it on one side to be filed at a later date. Dr. Walley insisted that all practitioners, in private practice or otherwise, should keep their hand-book up to date.

It would be very useful if, in the near future, the Royal College issued again the Guide to Professional Conduct. He made that suggestion because since 1951, when it was issued, there had been a number of changes, all of which had been recorded in the annual report of the Royal College; but it would be useful to see them again in a little hand-book drawing attention to the present position, and revising it in some aspects.

He was interested to note recently the possibility of having the names of veterinary surgeons in A.A. boxes, and he rather wondered how that fitted in with the question of advertising. However, that was another matter.

It was also important to know the relationship between the practising veterinary surgeon and the public health service. There were changes taking place all the time in the service, and if the veterinarian was not engaged in local government work as a municipal inspector, he could in fact miss the changes. The 1948 Act regulated the veterinary practice, but it also mentioned exemptions. Among those exemptions was that people over 18 years could do certain small operations—the castration of animals under certain ages—without being registered; but in 1927 the Royal College decided that it would prohibit the employment of unqualified persons to carry out such operations. Dr. Walley said he wondered where the dividing line came between the two concerning the employment of lay assistants in practice to carry out the castration of kittens without being qualified.

The author made reference to the veterinary surgeon being struck off the Register. It would be interesting to have some guide from his readings of Royal College reports as to which of the summary convictions might lead to that end, because often when seated the other side of the Bench, Dr. Walley had said to himself "There but for the grace of God. . . ."

Also with regard to the question of giving evidence, the author stated that professional evidence must be given

without bias. Then he went on to say "The intention is that justice shall be done." Dr. Walley appealed to the profession to make sure that it was true, and not the legal interpretation that justice shall appear to be done!

In the first part of the paper dealing with the duty to the State, the final paragraph skated nicely over a large number of things which affected veterinarians. First of all, there was the question of prescriptions. Dr. Walley drew attention to the fact that some veterinary surgeons had chemists as friends. Prescriptions in the veterinary profession were written as badly as they were in the medical profession. They should be made legible and should not be given unless the animal has been seen and the practitioner knew precisely what he was prescribing for. There should be no *ad lib.* distribution of prescriptions. Again, the fact that a veterinary surgeon gave a prescription did not mean that he should not have within his surgery adequate chemicals, drugs, or therapeutic agents with which to give immediate treatment. The responsibility should not be passed on to the chemist who might be closed.

As a dispenser the practitioner was regulated by a great number of Acts and Orders, starting with the Dangerous Drugs Act and the Pharmacy Act of 1868. It should also be remembered that the dangerous drugs cupboard should be kept locked, the dangerous drugs book kept up to date, and the last entry must not be less than 2 years old. It was also important that the correct labels should be put on dangerous drugs. The question of labelling when substances were dispensed from the practitioner's surgery sometimes caused trouble. The old lemonade bottle was suitable to contain a solution of copper sulphate, but it should have a label on it showing what it was and the concentration of the material in it. On one occasion an incorrect solution of copper sulphate was used to drench lambs and they died. Furthermore, if the dispensary was damp, as many were, the labels were apt to slip down the bottles. He also appealed to other bodies not to make their bottles look too much alike, because it had been known that stilboestrol had been used in error as an anaesthetic for dehorning.

It might be useful to mention the question of certificates. That was in his view the one weakness of the paper. A certificate emphasised the 3 Cs; it was necessary to be complete, careful, and conscientious in the examination, and only put on the certificate what had actually been seen. Again, a certificate sometimes had to go round the world and must therefore be completely legible and have a clear signature. All certificates should clearly state the time and place of the examination and, above all, the absolutely certain identification of the animal concerned, otherwise there was a chance of a switch, and a switch could mean that the veterinary surgeon himself might miss it at a later date and come in for some criticism as a result of the examination. That applied to certificates concerning carcases as casualties. Reference was made earlier in the Congress to the passage of carcases in the slaughterhouse, and certificates in that case should be absolutely complete so that the inspector knew what he had to work on.

With regard to the paragraph dealing with the duty to animals, the first duty was to relieve pain and suffering, and one of the things which the veterinary surgeon had to do, even if it meant losing a client, was to be absolutely firm with the client who came in with an animal which had been indisposed or in some measure of pain over a period of time. Some of those cases were very near to cruelty, and the personal feeling of the owner should not be allowed to interfere with the necessity of completing the animal's passage to the next world, because in any case the life span of an animal was shorter than that of its owner and its time would certainly come before the owner's. It was better to be hard for an hour or two than to prolong its pain over a period. The duty of the veterinary surgeon was to relieve its pain and suffering as soon as possible.

That led to the question of the injured animal. In the case of the large animal injured in the street, a veterinary certificate could be given to the constabulary which would order the destruction of the animal. That certificate should bear legal wording to the effect that the animal was mortally wounded and in such a condition that it was cruel to keep it alive. The veterinarian should not make any statement which it was not necessary to make, because the carcase was still the property of the owner.

On the question of error of judgment, in practice the veterinary surgeon was not responsible for an error of judgment so long as he had made a reasonable examination and interpretation of the signs and symptoms. He was responsible if it led to the continued cruelty of the animal.

With reference to the paragraph headed "Duty to Third Parties," and in particular to the question of professional relations, more use could be made of taking a second opinion during the course of treatment, particularly in the one-man practice, and also if the case had been difficult and was liable to lead to litigation. A second person present at the *post mortem* would in the end be of assistance, and would also assist some of those whom the veterinary surgeon might consult at a later date.

The question of master and servant was well covered, and he merely reminded those present that they should all have employer's liability even though they had no one in their employ at the present time.

Coming to the question of the new graduate, all the mistakes made in practice were not made by the new graduates. Speaking personally, he had seen some of the advertisements in the United Kingdom for new graduates, and they seemed to be getting a better deal on qualification. If a person were taken into a practice and was expected to be an able veterinarian, he should also be expected to be good enough to be a partner that day, but he was not. The colleges in this country gave as fine a practical training as anywhere in the world but there was need for more field experience. It was the duty of the master of the practice to give a period of actual practical experience in those first years, and not expect the graduate to do every job the first time.

As to the question of duty to the client, he would ask the author to try to enlarge on what he considered to be a "reasonable standard." The day he qualified Dr. Walley said he thought he was good and could give a reasonable standard. How would the author define a reasonable standard?

The author stated that "A veterinary surgeon can never be certain of his diagnosis." That should be amended to read "cannot always be certain," because Dr. Walley had met university lecturers who "by God they knew!" Again, the author wrote "A practitioner cannot guarantee to cure disease." He should also say "should never guarantee to cure disease." If that were said even flippantly it constituted an oral contract.

The question of negligence led to the question of damage. If the veterinarian were negligent in any way, the person had a claim for damages. If the practitioner received a call he could not refuse to go unless he had a good reason, and one good reason could be that he knew that the client would not pay. A call by the police was, of course, a different matter. When working with the client, the veterinarian was in either oral, implied, or actual contractual relationship, and it was necessary to go. Not long ago a certain practitioner was telephoned to attend to a cow in the early morning. The receptionist of that call did not make it clear that the veterinary surgeon himself or his assistant could go for some hours. No other veterinary surgeon was called, the farmer was not told to get someone else, and the ensuing 4-hour delay was decided by the court to be unreasonable and to have caused the death of the animal. After having made an examination it was necessary for the practitioner to make sure that he obtained consent to proceed with whatever operation or treatment was necessary, because he might find, if he did not obtain such consent, that he was under trespass. That could be very easily done. Even if it were desirable to give an anaesthetic for a complete examination, it was important to obtain consent and get the consent form signed. Furthermore, if the practitioner were to give an anaesthetic he must give adequate warning of the potential danger of any anaesthesia. If the animal were being cast down, adequate warning should be given that it might not get up. There were many instances of negligence and where adequate warning must be given.

The question of boarding kennels was not dealt with in the paper, but boarding kennels must be of good order

so there was no question of animals escaping. It would be interesting to know whether the author considered that a veterinary surgeon as the proprietor of boarding kennels had a greater responsibility to the clientele using the kennels than had the ordinary kennel owner. Dr. Walley considered that he had, and therefore it was essential that he should examine all the animals on arrival to ensure their state of health, and to make sure that no diseased animal entered the kennels. For that reason the boarding card was essential which should be signed by the owner that he left his animal there at his own risk. Even the best managed kennels could come unstuck. It had been known for someone's dog to go down the drain of a very well-managed kennel!

Another point concerned the client coming to the surgery. The client in that case was considered legally as an invitee, and it was necessary to warn him of any hidden traps. In other words, the client must be warned of any defects in the veterinarian's premises which the latter should know, even if he did not. At the same time his equipment and instruments must be in good order. There had been cases where instruments for preventing or stopping haemorrhage were inadequate. The practitioner was also responsible for keeping things like penicillin in the refrigerator. Some veterinarians kept semen in their refrigerator for clients, and it was advisable to have some sort of consent form indicating that they were storing it subject to the mechanical ability of the machine to keep it under the right conditions. If there were an electrical breakdown, the veterinary surgeon would be liable unless he had a "get out" clause.

The Acts and Charters gave the veterinary surgeon the right to sue for fees; but there was a sting in the tail. Claims for negligence often arose after the practitioner had pressed for his fees, and that led to what was perhaps the most important matter in the administration of veterinary practice. Veterinarians spent their time advising agriculturists to keep adequate records of all kinds, but they were themselves a little incomplete in that direction. Unless the veterinary surgeon kept adequate records he would never be in a position to defend his actions in retrospect, because unless his day book or ledger was complete, he would not have a clue what he had done, and the farmer's diary might be more up to date than the practitioner's. That was not good enough. The biggest problem facing the veterinary surgeon as an expert witness was the inadequacy of his own records.

If a veterinary surgeon gave free service to a client, he was still responsible for the animal, and once he started to give it treatment he could not abandon it. However, as the author pointed out, if the veterinarian were a reasonable man and joined a suitable society, he need have no qualms so far as his professional life was concerned.

The General Discussion

Mr. H. F. Hebeler (Langport): "I wish to thank the speaker for a most valuable paper and the opener for a contribution which tinged the law with humour. I wish to pay a tribute to the work of the Defence Society and to comment on the poor support it receives from practising veterinary surgeons: the use of private insurance for protection deprives the Society of experience and takes advantage of free advice from other members.

"I had understood that, on accepting a client, an unwritten contract was made and that there was a duty to attend when called. There is a tendency for clients to become unreasonable in requiring attendance, and conscience and duty to the animal may clearly not apply to such calls. I should like to know how far the contract may be enforced in such cases, how much it is affected by the client being a bad payer, and how such a contract may be terminated —must it be in writing?

"How far can such a contract apply to single-handed small-animal practices where a lock-up surgery is abandoned at the end of the day without alternative arrangements being made for attendance?

"I would like to endorse the need to extend consent forms for operation to cover anaesthesia—it can reduce anaesthetic mortality in a surprising way!"

Mr. L. G. Anderson (Aylesbury): "I should be grateful if the speaker would clarify the responsibilities of the veterinary surgeon towards injuries to farm workers assisting in the handling of animals. I had thought that the veterinary surgeon was acting at the request of the owner and, up to that point, was a servant of the latter; if stockmen were carrying out normal duties—as they were when controlling animals for other purposes—how far was the veterinary surgeon responsible?"

The Reply

Mr. Stevens, in reply, said it was quite true that all the dangers pointed out by Dr. Walley did exist, and the aspects of law were present, but the veterinarian knew the dangers and the pitfalls and should take care. Because thousands were killed every year and thousands more were fined, he did not stop driving his motor-car!

Reference was made to the exemptions under the 1948 Act. Certain people over 18 years of age could perform certain minor operations, but contrary to that the Royal College laid down that the veterinary surgeon must not, for certain operations, employ unqualified assistants. A legal standard for a profession was not sufficient. There was a moral and ethical standard over and above the legal minimum. The law stated that certain people might do certain things, but the Royal College with greater knowledge of what was required and the standard of care due to animals said "Although the law allows certain people with no training to do this, you as professional men must not be associated with what we consider are such poor practices." In every sphere of professional life there was always a difference between the minimum legal standard and a desirable professional aim.

The question was asked: What would rank as a summary conviction for striking off the Register? Felonies and misdemeanours, which were brought on indictment, were sufficiently serious in themselves to warrant striking off. If a veterinary surgeon were guilty of such he could not maintain the dignity and standard of his profession; but nobody knew what was the reprehensible standard of a summary offence. The Committee of the Royal College responsible for discipline would have to decide each case on its merits. Parking one's car in a prohibited place was a summary offence, but nobody would regard that as reprehensible or likely to lower the dignity of the profession; but commiting a public nuisance or committing obscene behaviour was also a summary offence, and would not enhance the dignity of the profession.

Dr. Walley suggested that lawyers were more interested in justice being seen to be done rather than being done. He had misunderstood. Justice being seen to be done was additional to justice being done.

On the question of whether the veterinary surgeon who issued prescriptions and did not dispense himself had to have a reserve supply of drugs, naturally he must, not only for his own professional standards, but also at law. It was a well-known fact that animals required emergency treatment, and for emergency treatment one went to a veterinary surgeon. If that veterinary surgeon did not have a minimum supply of drugs and appliances with which to render that emergency treatment, he was not acting as a reasonable man. He could not pass his professional responsibility on to the chemist or wholesale drug house.

The use of lemonade bottles for anything other than the lemonade by the manufacturer was now contrary to the Merchandise Marks Act, 1954, and also a violation of common law trade marks rights.

Dr. Walley sounded a word of warning in regard to the certificate for destruction in an emergency, and suggested the use of the minimum and legal wording. The author emphasised that. If the veterinarian elaborated on it, not only was his certificate not quite true, but he might open himself to a common law action for trespass, and that might involve him in the payment of the value of the animal.

As to the definition of "reasonable," he reminded those present that he was a lawyer and although he used the word "reasonable" every day of the week, he did not know what it meant! The reasonable man had been defined by two great common law judges, one in Great Britain and one in the United States. The British judge said that a reasonable man was the man on the Clapham omnibus, but he had changed in recent years. The American judge said that a reasonable man was the man who cut

the lawn in his shirt sleeves on Sundays and who read the comic supplement! What they were probably getting at was that the average man in any station of life was the one that his brothers in the profession would expect to find. A man was judged by his peers, and if a claim for negligence were being brought against a veterinary surgeon, the test of whether his action was reasonable or not would not rely on the judge or the lawyers. It would rely on what expert evidence was brought from the other side by the other veterinary surgeons. It was one of the tragedies that in medicine, veterinary practice, and in architecture one can get people who had been trained to the same standards to stand up in court and cut the ground from under each other's feet. The standard of care was that of the every-day veterinary surgeon. He was not expected to have the latest equipment or have the latest discovery from the drug house. All he had to do was to carry on as the average man in his area would carry on, and he had nothing to fear. If one veterinary surgeon were asked to give an opinion about another, he should give that opinion honestly and should not try to build himself up at the other man's expense. In that matter of reasonable standard of care, the greater number of cases were brought in the medical field. Conditions lent themselves to it. There had been a significant trend in recent years on the part of judges to disallow claims for negligence to a greater extent and to allow more for professional judgment on an every-day basis to be taken. They were not expecting the surgeon to be the insurer of all those he treated. All he must do was to act as an ordinary man in general practice, unless he held himself out as being something better.

A question was asked about an implied contract and whether the veterinary surgeon must go out to a call or not. If the practitioner regularly attended a person's animals there was an implied contract that he was that person's veterinary surgeon, and he must on all and every occasion when necessary attend to those animals. If that person sent a message and asked for the veterinary surgeon to visit his animals and the latter did not, he broke his contract and might well be liable for damages for anything that occurred because treatment was not given promptly. If that veterinarian was away or out on another case, whoever took the message must state clearly "Mr. Blank is not here. I am not expecting him home until this afternoon. I will give him your message as soon as he arrives, but if it is urgent will you contact another veterinary surgeon." Of course, the veterinary surgeon did not have to go to any stray inquiry.

If a veterinary surgeon had a client who did not pay his bills, then he could, of course, sue him immediately. The client would probably put in a counter claim for negligence. The veterinary surgeon could, alternatively, say "Well, he owes me £20, I will call it a bad debt, but I will refuse to give him any service until he pays." It was not enough in law to wait until the client rang up and asked for attention and then refuse until he paid, because there was an implied contract for the practitioner to treat his animals irrespective of payment. There was an implied condition of the contract that the client would pay, but when and how had never been stated. If the practitioner decided that a client was not worth dealing with because he was a bad payer, he should write to him enclosing an account and pointing out that unless the account was paid by the end of the month, he, the practitioner, would no longer consider himself the person's veterinary surgeon. A contract could be varied by word of mouth as in writing, but the advantage of writing was that it was evidence. That was the legal position.

The author's view was that the veterinary surgeon who ran boarding kennels would be expected to give a higher degree of care than the unqualified person. The man in the street taking his animal to be boarded at the veterinary surgeon's kennels would expect a higher degree of care and would expect qualified attention as compared with the unqualified person's kennels. It was up to the veterinary surgeon to give that higher degree of care and to charge accordingly, because if a person expected and received a higher degree of service, he could also expect to pay higher fees.

Dr. Walley quoted the case of the client coming to a surgery and being in the position of an invitee. Since then there had come into force the Occupiers Liability Act, 1957, which had removed all the old classes of invitees, licensees, etc. To every person who came on to one's premises for whatever purpose the owner owed what was described in the Act as the common law degree of care. But the Act did not state what that degree of care was! The Act had in fact made any occupier of premises almost an insurer of all those who entered them, and it was a very heavy burden indeed.

If a veterinary surgeon held animal semen in his refrigerator for someone he was a voluntary bailee. If he were a paid bailee it would be necessary to give a very high degree of care. All that a voluntary bailee had to do was to look after the goods as if they were his own. If he looked after them less carefully than he would his own, he was liable. It would be well to get a signed statement from the owner that the goods were there at his own risk.

With regard to the question of the lock-up surgery in the urban area, the man who ran a single-handed practice and a lock-up surgery was, in his view, liable at all times to give a service to his own clients, and it was a legal liability. If he wanted the glories and profits of a single-handed practice and desired to live in a nice house out in the country instead of over the surgery, he must accept the burdens as well as the benefits. If he left the lock-up surgery he must leave his telephone number in the window. He had not to be available 24 hours a day, but he must be able to be got at. When he went on holiday he must, in law, make arrangements to provide some sort of cover for his clients.

The question was raised concerning assistance from either the farmer or the farm hand and the liability of the owner. In order to clarify the position it was necessary to draw a distinction between the words "hold" and "help." If the farmer or farm hand held an animal it was their animal and it was not the responsibility of the veterinary surgeon what happened at that stage. But once the practitioner had got beyond the holding stage and examination stage and was about to carry out the necessary procedure, if the farmer or farm hand gave assistance he ceased to be the farmer or farm hand and became the agent of the veterinary surgeon, because immediately the veterinary procedure had started, in law the farmer knew nothing about it, and whatever assistance was rendered was, in law, given under the instructions of the veterinary surgeon, his care and guidance. If the farmer thought he knew better, the veterinary surgeon should say "I cannot carry on."

On the question of ethics, in law the veterinarian gave the best advice he could. The next practitioner who came along might be better, but it was a question of ethics, because the second man should not attempt it unless he had permission of the first. There should be a rapprochement between the two. As to the second opinion, one would have thought that with good feeling between veterinary surgeons a second opinion could frequently be useful. In any case, in all probability a second veterinary surgeon would not give an opinion to a farmer or to an animal owner, but would discuss it with the first veterinary surgeon.

As to the Dangerous Drugs Act, the veterinarian was not exempted from stating on the label the full details required. That exemption was given only to medical practitioners for the simple reason that the doctor's medicine went to the bedside of the patient who could read the label. In the case of the animal, of course, the medicine was given to its owner and there was no reason why a full disclosure should not be made.

Finally, with reference to the question of giving what was tantamount to a signed opinion, the point frequently arose in Ireland and the author had been asked to express an opinion on it quite often. The veterinary surgeon could not, of course, give a complete diagnosis or give a warranty in a few minutes having looked at an animal on market day. On the other hand, he could not take the animal away. The author suggested that any opinion given should be qualified by the words "To the best of my knowledge on the information available to me." If every veterinary surgeon did that, it would not be possible to play one off against the other. As far as the vender was concerned there was nothing to stop him putting in the conditions of sale anything he wished, provided they were accepted by the purchaser.

Dystocia in the Bovine Animal

BY

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Introduction

THE subject of bovine dystocia is perhaps the most fruitful of all for discussion amongst practitioners. Undoubtedly the miracle of birth touches even the most case-hardened of us, and when this birth has been assisted, or indeed only made possible, by our personal efforts, we feel a unique and justifiable satisfaction. The problems of dystocia in large farm animals frequently try our stamina, skill, endurance, and ingenuity to the extreme. I think these problems are unusual by virtue of the size of the dam, the size of the uniparous or biparous foetus, the strength of the uterine contractions, the full skeletal development of the foetus, and the complete absence of any preclinical examination, combined with the varying skill, knowledge, or experience of owners or attendants. They pose a series of individual cases of infinite variety.

In spite of the above observations I have found the writing of this paper no easy task. The teacher can, with relative ease, prepare a lecture for students, and the worker attached to a teaching school or research station can produce series of graphs, tables, and figures which are frequently of great interest and value; but for a practitioner to write, on a topic of such great interest, something which will be of value to colleagues of comparable experience, and equal or greater skill, is a most difficult task. I can only approach the problem as a practitioner sees it, speak of some of my own experiences, ideas, and methods, and hope to stimulate an interesting discussion.

The Normal Parturition

Now firstly, let us realise that a very high proportion of bovine animals manage to deliver their calves without assistance, and many of those which receive lay assistance would probably manage very well by themselves if left alone. The average stockman cannot resist pulling on the legs as delivery becomes imminent. It follows therefore that the majority of bovine parturitions we attend are pathological when we are called.

It is true that the quality of stockmanship is rapidly declining. The help available is often limited in both quality and quantity, and it is not uncommon to be called out, simply because the stock-owner has no one else to assist him, to apply traction when delivery is slow. At the other extreme we still occasionally find the case on which half the village has tried its skill. As a general rule labour has either appeared prolonged without results, or the attendant has made a vaginal examination and found things abnormal. In the vast majority of cases when we are asked to attend, immediate attempts must be made to effect delivery.

Before proceeding further, it is perhaps necessary to give some consideration to deviations from the normal pattern, which may give rise to the belief that dystocia is present. Unfortunately, the normal pattern of birth is singularly variable in both character and duration. The early stages of parturition frequently pass unnoticed, by appearing to be little more than changes of normal habit. There may be an urge for solitude, and possibly some restlessness and interruption in feeding and rumination. The cervical mucus may be seen discharging from the vulva, the tail may be raised, and the animal will gradually pass into full (second stage) labour. The first stage may last up to several days, and generally no interference is called for. The second stage may vary from one to several hours and its progress should be carefully watched. As a general guide, I would suggest that if nothing is visible *per vagina* after 3 to 4 hours, the stockman should make an examination. If the cervix is not fully dilated and the membranes unruptured, further time should be given. Once the membranes have ruptured parturition should follow rapidly—at least feet and nose should be found in the vagina or vulval entrance.

The main point to bear in mind is that progress, even if slow, should be fairly continuous. It has been my experience that in contradistinction to the multiparous animals, once expulsive efforts have ceased they rarely start again (except in cases of preparturient hypocalcaemia), and further, if the steady dilatation of the cervix ceases before completion, either due to uterine fatigue or failure of the foetus to enter the pelvic inlet, it rarely re-starts, even when the primary cause is corrected.

Labour very rarely appears to cease before the rupture of the uterine membranes, except in cases of torsion, but I am convinced that once those membranes have ruptured a series of events, all of which are adverse to normal parturition, occurs fairly rapidly if delivery is delayed:—

1. Foetal fluids are lost.
2. Death of foetus follows compression or rupture of cord, or separation of membranes.
3. Vaginal mucus is lost and the vaginal canal becomes swollen and dry.
4. The uterus contracts on to the foetus and makes manipulation very difficult.
5. Emphysaemia of the foetus develops.
6. Infection of the genital canal and uterus occurs.
7. Progressive exhaustion and toxaemia of the patient follow.

It is impossible to lay down absolute rules as to when assistance should be given, but I feel that progress should be continuous and relatively rapid once

the animal is in full labour. Any real cessation of progress should be investigated promptly. It is, of course, a great mistake to rush things which are proceeding in a normal and orderly manner, and frequently damage is done by too great haste. Great harm can also be done by undue delay. All of us here can recall countless cases where our work has been made most arduous, and both dam and foetus have been lost or suffered prolonged illness, due to undue delay.

Dystocia

The causes of dystocia have been referred to as foetal and maternal, but this is not a very satisfactory classification. Many dystocias are a combination of the two, and others are influenced by extraneous, concurrent, or indirect causes. I will attempt to list some of the causes commonly met in practice.

1. *Time Factor*

Brucellosis, vibriosis, and trichomoniasis are all diseases causing early expulsion of the foetus. As the latter is frequently small, delivery may be easy, but the dam does not go through the normal processes controlled largely by hormone release—and difficulties may arise. Accidents, malicious or accidental interference, insemination, certain drugs such as sodium iodide and ergot, and some acute infections may cause similar difficulties.

2. *Mechanical Factors*

Under this heading I think primarily of torsion of the uterus, but occasionally preparturient prolapse, twin cervixes, developmental remnants, rupture of the pre-pubic tendon, uterine inertia, and possibly recumbency, may be concerned.

3. *Concurrent Disease*

Primarily preparturient hypocalcaemia. This condition is becoming more and more common as advanced methods of feeding and management are applied. It is, however, frequently a misnomer because the great majority of such cases are in first- or even second-stage labour, although no expulsive efforts are noted. There is, in fact, a paralysis of the uterus as with bladder and rectum. Once blood calcium levels are restored, labour rapidly recommences. I make a point of examining such cases *per vagina*. If presentation and position are normal I leave matters alone, explaining the situation to the attendant. It is sometimes necessary actually to deliver the foetus.

4. *Maternal Dystocia*

In addition to some of the above factors we may also consider: Atresia cervici, pelvic abnormality, and Hydrops amnii.

5. *Foetal Dystocia*

This may be associated with: incorrect position, presentation, or posture, with monsters and multiple pregnancy and absolute foetal oversize.

6. *Combined Dystocia*

This may be the result of dead or decomposed foeti combined with loss of fluids, contraction of uterus, and tumefaction of reproductive canal, and also with relative foetal oversize.

The Approach

It will be appreciated that frequently one has little idea of the type of trouble to expect, nor of the conditions under which they may be found, so that some set forms of equipment and protective clothing are necessary. The patient may be in a clean loose-box with ample bedding, light, hot water, and assistants. On the other hand she may be recumbent in a morass, or partially submerged in a pond or ditch. Rubber boots are, of course, necessary, and various obstetrical gowns are available. I must admit that if internal manipulation is likely to be prolonged, I generally prefer to strip and wear a rubber apron or rubber trousers. A sleeve protector is useful in simple cases but I do not like the restriction of anything around my arms.

The great majority of cases are dealt with by manipulation and reasonable traction with ropes or "slips." I am not a believer in carrying great quantities of complicated equipment. The human hand is the best obstetrical instrument of all. We have "calving boxes" constructed from aluminium alloy. They are about 24 by 12 by 12 inches and have an end compartment which contains disinfectant, soap, pessaries, pituitrin, local anaesthetic, syringe, and spinal needle. The tray contains a few hooks, a snare introducer, embryotome wire, and handles, and in the bottom three or four slips, two short lengths of "fork-handle," and a set of pulleys. The latter item may cause a few raised eyebrows, but I will refer to it later. A knowledge of knots which do not slip, but which can be undone, and of splicing is of help. I find many slips have much too big a noose and are difficult to apply snugly around a small leg. Nylon slips are strongest but cotton ones are softer. Hemp and sisal are quite unsuitable. My first embryotome consisted of 15 inches of 2-inch metal piping belled at the ends, and Bowden cables with soldered loops for the two bits of fork-handle above mentioned. This was quite the best equipment I have ever had for the purpose. I have purchased several patterns of embryotomes since then; all are too heavy, too long, difficult to thread, prone to fray the wire, and wellnigh impossible to clean. The handles rarely grip the wire satisfactorily; but modern wire of Swedish or German origin is excellent.

The actual site of operations is not always a matter of choice but, where possible, reasonable conditions should be found. The "buck-rake" is a very useful implement for moving the recumbent animal, but may not be available. The floor of the shed is of great importance. I have yet to discover a way of rendering damp concrete "slip-proof," and am prepared to sacrifice the hygiene of this type of flooring for the safety of a mud, chalk, or dung floor. The animal should be secured by a rope which can be rapidly loosened, and as a general rule in a standing position for a preliminary examination. Examination and manipulation are usually easier if the standing animal is facing downhill, or the recumbent one on her left side.

Assisting at Parturition

I do not propose to bore you with a detailed dissertation on correcting the various abnormalities which may be found in position and presentation. These will be all too familiar to you. I would say in passing that I find the position with the head turned straight back one of the most difficult to deal with, as I am not blessed with a very long arm. With the aid of a snare introducer I can usually get a slip around the neck and then, almost invariably, amputate the head. I try to avoid the use of spinal anaesthesia where possible because one needs the expulsive efforts of the patient once the position or presentation is corrected. I do, however, usually employ it for a breech presentation to obviate the risk of rupture of the uterus when bringing the legs around and back.

The most important thing is to learn by experience just what you can do, and to decide rapidly which method is likely to bring success. There is nothing so wearisome to all concerned as prolonged and fruitless manipulations which have to be abandoned in favour of other methods.

If parturition has advanced to the stage where correction is necessary, it is usually desirable to proceed with delivery. I have in the past attempted to leave cases after correction in the hope that delivery would proceed normally. I have been constantly disappointed. The same may be said of torsions which have been corrected, and labours that have ceased before delivery takes place.

As I have said already, under these circumstances labour is unlikely to recommence and the ultimate death of dam and foetus is almost certain unless effective assistance is forthcoming.

Assuming that the position and presentation of the foetus are correct and delivery is due or overdue, the obstetrician is faced with four alternatives:—

1. Waiting.
2. Forced extraction.
3. Embryotomy.
4. Caesarean section.

1. I have already discussed this and regard it, generally, as a fatal procedure.

2. The normal method of delivery is by virtue of pressure occurring in rhythmic waves by the uterine musculature, combined with contraction of the abdominal muscles. In other words, controlled and reasonable force. Where this force ceases to exert its influence it is not possible to simulate it with any degree of exactitude. One admits pulling is not the same as pushing. It is, however, a method of applying force, and if applied with reason and control, and in the correct direction, would seem to be the logical approach. I have frequently been amazed at the degree of force which an animal will stand without ill-effects. After all, the normal expulsive efforts of the large animal represent a very high pressure per square inch. The healthy animal will stand a degree of controlled force which might appear to the uninitiated as approaching the brutal, far better than she will stand the hazards of prolonged internal interference, with the trauma and infection which must follow major embryotomy operations. The essential thing is to determine as rapidly as possible how much force one can apply, *and whether such force is likely to achieve the desired result.* I know of no means of assessing relative or absolute oversize by measurement.

The strength of four men has been suggested as a general guide; however, are four men always available? Can one always control the activities of four men who are in a hurry to "knock off" and get home, or may only understand Italian, German, or Polish? I always have a set of pulleys which is used by *one* man under my immediate direction. If pressure is controlled and synchronised with the expulsive efforts of the cow, or, where these have ceased, patiently maintained at a steady level, the degree of dilatation that can be achieved is surprising.

If necessary the cervix may be incised in several places with relative safety. Pressure should be applied evenly to head and legs, or to legs and head alternately, the head being held by a slip behind the ears and in the mouth. If the foetus is alive the chief pressure should be on the legs. In spite of some reports to the contrary, it is surprising how much pressure of this kind a foetus will stand, and it is very rarely injured in the process.

There are, of course, risks which are well known to you all, but with care these can be reduced to the minimum.

3. Embryotomy. Without doubt this method is of great value for the removal of a limb or head, if through ankylosis or other reasons it is impossible to rectify the position. I feel, however, that prolonged embryotomy operations are usually contra-indicated. The strain on all parties concerned is extreme and utter exhaustion usually follows. Asepsis gradually "goes to the wall" and the ultimate result is a dead foetus, a very sick dam, a very tired veterinary surgeon, and an ill-tempered group of helpers. In addition prolonged after-treatment is usually necessary. In the vast majority of cases prolonged embryotomy should be rejected in favour of:—

4. Caesarean section. This operation undoubtedly has a useful place in bovine obstetrics. The indications are simply those cases which are unlikely to respond to manipulation, forced extraction, and simple embryotomy. You will hardly need a full list of causes—the bulldog calf, the grossly over-sized foetus, the monster, the dam with uncontrollable pre-parturient prolapse or torsion, and so on. In my experience, however, by far the commonest cause is the development of the chain of events described above, which develop when assistance is delayed too long.

To the young and inexperienced veterinary surgeon the thought of undertaking this major operation is somewhat terrifying; but with experience it becomes a relatively simple and straightforward procedure. This is not the occasion for a detailed description of the operation. I tend to work on the assumption that the standards of pre-operative preparation, operative asepsis, and post-operative nursing achieved in the

human field are not usually possible. It is, therefore, necessary to consider the tissues of the host in preference to the bacteria which may invade them. In other words, speed and simplicity are called for.

The major difficulty is the size and weight of the gravid uterus. I generally operate under a spinal and local anaesthetic, make a vertical left flank incision, use monofilament nylon for *all* sutures, and hope to be on and off the farm in about 1½ hours. The percentage of success is high—probably about 80 per cent. recovery—but I confess that first-intention healing is not always achieved.

Third-stage Labour

I am afraid that I do not know the cause of retention of foetal membranes in the absence of the usual uterine infections such as *Brucella abortus*, but I cannot subscribe to the view that it is associated with uterine inertia. The cotyledons either separate rapidly or are firmly adherent at birth and no amount of uterine contraction will detach them. Frequently the cervix is nearly closed in two or three days, with the membranes still firmly attached. In a high proportion of cases of prolapse of the uterus the membranes remain firmly attached.

I am sure this is one of the occasions when waiting pays. I never work hard at a "cleansing case." I like to be called about the third day, but if the membranes do not detach easily, I give further time until they do. Any attempt at forceful separation invariably leads to trouble.

Where expulsive efforts continue for long after the delivery of the foetus, prolapse may result. Where I feel there is danger of this occurring I always give intravenous calcium. If possible, I like to see a cow on her feet before leaving the premises.

It is to be hoped that I have not disappointed you by the absence of any significant tables by which I can prove any of my points, or of any brilliant or revolutionary ideas. I have tried to put on paper my ideas on normal and abnormal parturition, and the best approach to the latter. I am looking forward with interest to the discussion which I hope I may have helped to stimulate.

THE SPEAKER'S INTRODUCTION

Mr. L. G. Anderson, in presenting his paper, said that in order to avoid relating a number of technical details, he had approached the matter by trying to visualise the picture of the normal and the abnormal parturition as a practitioner saw it in the field. It was because of that that there were no references in the paper. Because there were no references he would not want it thought that he had never referred to any earlier or more learned gentleman than himself! Of course he had, and he took particular notice of the paper which the Chairman presented to students at London not very long ago. However, as the paper under discussion was largely dealing with personal experience, the author had not included a number of references.

There were one or two small points which he desired to raise in connexion with the paper. First, he referred to what he found was one of the most difficult presentations —namely, with the head turned right back. What he meant was the head turned straight back and not turned to the right or to the left. The lateral deviation of the head could often be difficult, but the position with the head turned straight back must prevent the foetus from proceeding very far into the pelvic inlet, so that one had the difficulty of distance which was both the whole length of the maternal pelvis plus the width of the base of the foetal neck. It would also be noted that the heading of the paper was simply bovine dystocia, so no reference was made whatever to sheep, although it had been rather common lately to speak of dystocia of the cow and the ewe under the same heading. That was not unreasonable because the pattern was somewhat similar, but he had confined his remarks purely to the bovine animal.

One point which might well have been mentioned in the paper but which was not mentioned concerned one or two steps which might be taken to try to prevent the very difficult cases with which the veterinary surgeon was presented on occasions. On the one hand a great deal could be done by reasonable breeding. There seemed to be no doubt that the bulldog calf in the Ayrshire was an inheritable factor, and by careful breeding could probably be bred out. The same might apply to the Dexter. The other point was the use of reasonable cross-breds to avoid over-size foetus. He had in mind the use of the Aberdeen Angus bull with the Friesian heifer which had been shown to produce a useful calf, and which made the parturition of the Friesian heifer much easier.

The next point of course was the very careful recording of data, and observation of any changes on the part of the farmer or his attendant. The author was particularly impressed 2 days earlier in connexion with a case when the farmer told him that he was fairly certain the cow was calving, although it was a little premature. The cowman had noticed something wrong, and the author was asked to examine the animal. He questioned the stockman carefully as to what he had seen, and he replied that he had noticed the passing of what appeared to a small amount of afterbirth as he was driving the cow into the shed. What he had actually seen was not known (probably cervical mucus), because on examining the cow the author found the membranes were not ruptured. But he also found that the cervix was fully dilated and there appeared to be uterine inertia. There was a twin pregnancy, and with the first calf he found the withers and shoulder coming into the pelvis. It was a simple business. Once the membranes were ruptured the calf was able to be turned into the normal position and delivery was effected easily. He congratulated the stockman on his observation and pointed out how pleased he was that he had noticed what he did because, if he had not noticed it and the membranes had ruptured, any real progress in delivery would have been impossible; as the uterus contracted on to the twin foeti, the obstetrician would have had a very difficult job to do. That example fitted in the general theme of the paper that once a certain stage was reached, it was necessary for progress to continue.

The Opener

Mr. H. Holroyd, in opening the discussion, said he desired to take an early opportunity of saying that the paper was thorough and was based on careful observation of the author's practical experience over a long number of years. Mr. Holroyd had found difficulty in finding the correct line of approach in opening the discussion, because he found himself very much in agreement with the contents of the paper.

Dystocia in the bovine animal must have been one of the earliest subjects to be discussed amongst a gathering of veterinary surgeons, for it had been ever present and must have presented as many problems in the past as it did to-day. Like the author, Mr. Holroyd could only approach the subject from a practitioner's angle, and he had no charts or statistics to illustrate the frequency of occurrence or the different types of dystocia most commonly encountered in the bovine species.

The author commenced his paper by discussing the normal parturition with which all concerned were familiar. In that connexion, as he so rightly referred, the quality of stockmanship was rapidly declining, and the help available at a calving case was at times anything but satisfactory. There appeared nowadays to be an increasing tendency amongst some stock-owners and others to believe that given sufficient time a cow would eventually calve of her own accord. They forgot that abnormal presentations did occur and that it was impossible for delivery to take place unless such abnormalities were corrected. How many times were

veterinary surgeons called to a case where delivery should have been effected 6, 12, or even 48 hours previously and in consequence were presented with a foetus not only incorrectly presented, but emphysematous and the patient with a dry swollen vaginal canal. How much better it would have been for the veterinary surgeon and the welfare of the dam if the owner had realised those things earlier. He agreed with the author that once second-stage labour had commenced, progress should be continuous and that initially a period no longer than 3 to 4 hours should be allowed before an examination was made. If everything was normal, no harm could be done in waiting a little longer; but if an abnormality were apparent, the sooner it was corrected and delivery effected the better.

The author did not think that the classification of the causes of dystocia as foetal and maternal was entirely satisfactory, and whilst admitting that many dystocias might be a combination of the two, he attempted to classify the causes commonly met in practice under 6 headings. To refer briefly to the first heading, namely, the time factor where the author related conditions such as brucellosis, vibriosis, etc., which did cause premature birth, Mr. Holroyd felt it would be agreed by all that of those diseases, brucellosis was the main one that could cause any trouble, and when it did occur it was necessary to give sufficient time for the opening of the cervix and dilatation of the vagina.

Under the heading of maternal dystocia the author mentioned, among other conditions, Hydrops amnii, but Mr. Holroyd had been unable to find any further reference to that throughout the paper. It would be of interest to know how often the author encountered that condition, and also his method of dealing with it. Those cases caused Mr. Holroyd some concern, and whatever one did it always seemed less than adequate. The animal was usually seen anything up to two months from her full time with a great uterus, having lost a considerable amount of flesh, sometimes having difficulty in rising. Her heart was also in poor shape, and she might not be feeding well. Was it better to carry out a caesarean section immediately or try to induce abortion; or was it better to do nothing except wait, hoping that the animal would have sufficient strength left when she ultimately delivered the water and the calf.

No doubt all veterinary surgeons had their own different approaches to a parturition case. A calving case was usually an unknown quantity until one arrived at the case. The calving of cows partially submerged in ditches or even in fields was, in his view, highly unsatisfactory for everybody concerned, and he more or less insisted that the animal should be housed. The days of calving cows by the light of one or two candles had also passed, but veterinary practitioners were still frequently presented with animals in a stall containing little or no bedding and a scarcity of hot water which was generally only lukewarm. Rubber boots and parturition gowns were a necessity, but he found a sleeve protector useless. He usually approached a case with the minimum of equipment—3 or 4 nylon ropes, a couple of hooks, and an embryotomy knife, believing, like the author, that the human hand was the best instrument of all.

As regards embryotomes, he had only had experience of one type and that was the one which he originally obtained from Denmark. He had used it on many occasions but had not found it entirely satisfactory, the chief objection being that it was difficult to thread the wire through the instrument again after one had passed it round the part to be removed. It was also more or less impossible to clean satisfactorily. He had not had occasion to use that instrument for many years.

He did not intend to discuss at any length the correction of the various types of presentation met with in practice, but it might be amiss if he did not comment on one or two of the most difficult types.

The author referred only very briefly to the correction of abnormal presentations. In fact he referred to only one condition and that was where the head was turned straight back along the spine of the calf, a condition that could occur through a too keen stockman pulling vigorously on the legs without being sure that the head was following. It would probably be agreed that that was a very rare presentation, one which he had encountered only a few times during the past 20 years. There was probably no doubt that amputation of the head was the easiest and quickest method of dealing with it.

It would be interesting to hear from the author his methods of dealing with the far more commonly encountered condition and one which was often responsible for the veterinary surgeon being called in to a calving case. He referred to that presentation where the head was turned laterally, either to one side or the other. Like the author, he was not endowed with a long arm and those cases could cause a great deal of trouble. The method Mr. Holroyd invariably adopted was to put a hook into the orbit of the eye, preferably at the internal canthus, then by careful manipulation return the head to the normal position.

In those cases where it was only possible to touch the tip of one ear, one could gain that extra inch or so by adopting one or more of three methods. They consisted of pulling a little on the leg on the same side towards which the head was turned, or inserting a hook into the external auditory meatus and gently pulling, or by making an incision into the neck and inserting a blunt pointed hook and again gently pulling. Did the author invariably amputate the head? Would he perhaps agree that it was easier to amputate a fore limb? Mr. Holroyd found that it was quicker, when it was impossible to return the head to the normal, to amputate a fore limb, preferably the one on the same side on which the head was turned. By doing that it was usually then possible to hook the head in some position and return it to its normal position. An interesting observation might be referred to, namely, that he found in 80 per cent. of cases with the head back, the head of the calf turned to its right. Was there an explanation of that?

As regards breech presentation, Mr. Holroyd said he would mention only one point and that was where one was having difficulty in turning and raising the legs, a useful thing was to sever the tendons which would then greatly facilitate the operation.

Like the author, he also tried to avoid the use of spinal anaesthesia; but he was of the opinion that its use in many cases was most valuable, especially in those cases where the head was turned back and in breech presentations. Without its use it would be necessary to resort more frequently to embryotomy.

Mr. Holroyd endorsed the remark contained in the paper that an important matter was to learn by experience. In fact, the only way in which one could learn the art of calving cows was by practical experience. One must decide at the onset the best method of correction and the quickest and easiest way of delivery, and get on with the job. He could not subscribe to those views which had recently been expressed of leaving things alone and the cow would in due time calve. When correction of the foetus had been accomplished, except in very rare cases the correct procedure to adopt was delivery. If that were not carried out one would only have to attend the case again when the foetus would most probably be dead, absorption of the natural uterine fluids would have taken place and the delivery would be far more difficult. In consequence more damage would be done to the dam. There was possibly one main exception to that, and that was in the case of a torsion of the uterus—a condition which the essayist passed over very briefly.

Mr. Holroyd recalled one case of torsion of the uterus where the os was more or less completely closed. The torsion was corrected and the animal did not calve for a further 48 hours, but then it did so normally. The authors remarks would be appreciated on the method he adopted when presented with a case of torsion. Did he find that all his cases were fairly tightly twisted, that is, to the extent where there was about half to three-quarters of a full rotation, when it was only just possible to pass the arm into the uterus, or did he encounter many cases of the type where there was only a very partial rotation? Mr. Holroyd had no figures available, but he felt that about half was encountered in each of those categories. He believed that the usual procedure in such cases was to roll the animal over and over in the direction of the twist. That method, besides not always being successful, entailed a great deal of hard labour and necessitated manpower

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and space which was not always available. He had found a far more simple method wnich, although perhaps not completely untwisting the torsion, resulted in allowing one to rope the limbs and head and bring them into the birth passage when, with traction, delivery could be effected. In passing it might be mentioned that the head of the calf was the main part that one should endeavour to secure. This method, which would be familiar to those present, consisted of pushing the abdomen of the cow upwards and letting it fall rapidly. If that were done a few times first on one side and then, if not successful, on the other, all the time the operator keeping his arm in the uterus grasping, say, a limb or head, one could usually get sufficient swing on the uterus to correct the torsion.

Before passing to further remarks, Mr. Holroyd said he would appreciate discussion on the case of the oversized calf or the undersized pelvic cavity of the dam. That could be relative, and it was not alway possible to appreciate it at the commencement. In fact, one was often called in when the owner had managed to get the calf delivered to the point where the fore end up to the ribs was delivered, but he could not deliver the hind end. The animal was a heifer and already considerable force had been exerted on the calf. Was it correct to apply more and more force with the possible risk of rupturing the pubic symphysis? Or was it policy to perform a transverse section, return the hind part to the uterus, turn the calf, and deliver it hind leg first, or would it be better to perform a caesarean operation?

Recently he was presented with such a case where the owner had not only pulled the calf into that position, but had pulled away the front and had left the hind end fast. Mr. Holroyd was able, with the use of an embryotomy knife, to incise the skin over the hip joint and then disarticulate that joint—the muscle round about was severed as far as possible—and that released the stifle joint and also reduced the diameter of the foetus. Delivery was then effected by the use of hooks into the remaining hind end. A further method had also been found useful. That consisted of carrying out first a transverse section, which must be done in a position as near as possible to the hind end, and then a longitudinal section of the remaining part. That was effected either by means of a wire or a hammer and chisel.

The author tabulated 4 alternatives which were offered when the foetus was in the correct position for delivery. Mr. Holroyd did not like his choice of words, that is, "forced" extraction. He understood completely what the author meant, but felt that the word "forced" conveyed that in every case one had to use means to deliver the calf. Admittedly he qualified that in his paragraph dealing with the question of the application of pulling. There was no doubt that application of force was often necessary while attending a parturition case. To obtain the greatest success it must always be co-ordinated to achieve the greatest benefit, that is, to extract the calf and, at the same time, to incur the least possible damage to the cow.

Mr. Holroyd did not consider that any general rules could be laid down as to how much force was going to be necessary to deliver the calf. How many times had one thought that at the commencement the strength of, say, 3 men would be sufficient, only to find that later it was necessary to employ much more strength. At one time he would have disagreed emphatically that the use of pulleys were indicated at all, the reason being that when one had 4 or 5 men pulling one knew what pressure was being exerted, whereas with pulleys one could not always be certain. It would be interesting to hear from the author the type of pulley he used. Was it one with one wheel at either end, or one with two wheels at one end and one at the other? Not being a physicist Mr. Holroyd said he would not know whether the strength of 4 men was equal or more than a particular type of pulley. The labour force available on farms these days coupled with the fact that many farmers were now using a Friesian bull on Ayrshire-type heifers and cows with consequently larger calves to be delivered through a pelvic cavity which was never intended for the passage of such calves, had of necessity caused one to resort to the use of such mechanical aids as pulleys and crow-bars. There was no doubt that those aids were useful, but they should only be resorted to in extreme cases and should then be used discriminately and always under control.

With regard to embryotomy, it would be possible to discuss that at great length, detailing all those types of cases where it was invaluable, also the methods of carrying them out. Nevertheless, suffice it to say that by carrying out a simple embryotomy, a difficult case could be rendered reasonably easy. He agreed with the author that prolonged embryotomy such as one had had to perform on such cases, for example, as schistosomus, was definitely contra-indicated to-day, and caesarean section should, with reservations to be mentioned later, be carried out.

Usually one had to approach the operation of caesarean section in his practice purely on economic grounds, for the majority of cattle were commercial cattle kept solely in the first instance for the production of milk and ultimately for beef. It was necessary to take into consideration all the factors appertaining to a particular case when that operation was being considered, *e.g.* the bodily condition, its age, its general health, whether there was any form of carcinent disease present, such as mastitis, its value as a milking animal provided it recovered, the veterinary surgeon's fees for the operation and its post-operative treatment. Mr. Holroyd was of the view that those things, amongst others, were not always fully taken into account before the operation was performed. He had heard it said by farmers who had had a cow operated upon "Never again."

Before passing to the consideration of third-stage labour, Mr. Holroyd said he would touch on one aspect of dystocia of which there was no mention in the paper. That was adequate lubrication. One was often presented with the case of the dry if not emphysematous foetus, with a dry vaginal canal and where, if more lubrication were present, delivery would be much easier. He was aware of the fact that soap and water could be used, even to the extent of putting 3 to 4 gallons of soapy water into the uterus; but surely it was high time a really efficient lubricant was developed?

Like the author, he did not know the case of the retention of the foetal membranes. He could not subscribe to the view that the majority of cases were due to infection, for in a large proportion of cases the animal had calved at her due date a perfectly healthy calf. Mr. Holroyd suggested that many of those were due to some hormonal imbalance, and might be connected with climatic conditions or husbandry, or the general condition of the animal at that time. It would be interesting to hear from someone more conversant with that aspect and, at the same time, explaining why so many cows that calved twins retained one of the after-births.

He reiterated the author's remarks regarding the "cleansing case" when he said that he liked to be called about the third day and never worked hard at such cases. Mr. Holroyd was of the view that if one attempted such cases for longer than 5 to 10 minutes, one did far more harm than good, causing unnecessary trauma and opening the way for further infection with consequent systemic disturbance and possibly a fatal result. Mr. Holroyd could not agree that prolapse of the uterus often occurred following dystocia and if it did, it was usually immediate when there was no time to give a calcium injection, although he would agree that the intravenous use of such was indicated in cases of post-parturient straining.

The General Discussion

The Chairman (Professor J. G. Wright) said that the subject under discussion was one in which he had taken some interest and he felt his position in the Chair restricted him, and that it would be quite wrong for him to say anything which might be controversial. Nevertheless he found it difficult to resist.

There was a tendency to over-simplify in one's mind that commonplace process, parturition. Yet, it was probably the most complex of all the physiological processes which occurred in the female animal, and veterinary surgeons must not be dogmatic as to how an individual case should be dealt with when the process went wrong. They must think in terms of what was happening inside the animal. Parturition was not a simple process analogous to defecation but was the outcome of a perfectly balanced hormonal

function. The placenta was commencing to degenerate, the blood which was required for oxidation of the foetus was being deviated to the mammary gland. Calcium required for uterine contraction was also being deflected to the mammary gland. The hormone relaxin had caused that remarkable organ, the bovine cervix, to relax so that it and the vagina formed a continuous vestibule. The uterus which had been passively contracting throughout the whole period of gestation, had now become acutely sensitive to the stimulating action of oxytocin. With the engagement of the foetal parts in the pelvic inlet and vagina, the auxiliary forces of the diaphragm and the abdominal wall came into play. These efforts built up to a climax which was the expulsion of the foetus. An interesting feature of the cow as compared with the mare, was that there seemed to be a natural lag of some 5 to 7 hours, during which the uterus was reasserting itself between the expulsion of the foetus and of the foetal membranes. With thoughts such as these we should try to visualise the true state of affairs when things go wrong, so that we can assist in a manner best fitted to the individual case, rather than be dogmatic as to what should be done and when.

Nature intended cows to calve unaided. She did not intend farm workers to introduce their dirty hands or veterinary surgeons their not-so-dirty hands, into what was primarily a sterile focus. The rate at which putrefaction developed in the uterus was, in part, related to the amount of contamination which had occurred beforehand, particularly when the foetal envelopes had been ruptured manually. Thus, once significant interference had occurred, the membranes being ruptured and the foetus dead, putrefaction advanced very rapidly.

Mr. W. K. Hunter (M.M.B., Ilkley): "I should like to enlarge on the matter of insemination causing abortion which was mentioned briefly in Mr. Anderson's paper. We have found in practice that it is quite safe to inseminate a cow up to 9 weeks after the insemination to which it has conceived, but that insemination after 10 weeks invariably results in abortion. Many cases of abortion attributed to insemination are really cases where the act of abortion has commenced, and the animal is showing signs of œstrus. Abortions resulting from insemination usually take 7 to 11 days. If the abortion occurs earlier than 7 days it is taking place from a causal factor other than insemination.

"I agree with Mr. Anderson about the causation of retention of the placenta, but I feel that in the main infective organisms are the cause. Maybe if we could find out more about these there would be another popular cause of infertility.

"As to manual removal of the placenta, I do not believe that this should ever be attempted. I appreciate Mr. Anderson's technique and approach, and the care he exercises, and realise it is easy for someone who has no clients to satisfy to say no cleansing. But I feel a healthy animal which comes well to her milk and food should be left alone and seen in 6 to 8 weeks when an intra-uterine irrigation may be indicated.

"Mr. Anderson mentions the desirability of serving Friesian heifers with an Angus bull, and undoubtedly the practice does result in smaller calves and easier calving. However, in our area we have found a swing against the practice owing to the results obtained by a progeny testing station which has shown that pure-bred Friesian steers mature much quicker than any cross-bred Friesian, and indeed, although the quality of Friesian beef is not of the acknowledged primest quality, it is a good-quality, lean meat popular with the housewife. A further point is that cross-breeding also results in one crop of dairy heifers being lost to both herd replacement and progeny recording. Thus sound veterinary advice might be antagonised by other economic factors."

Mr. J. McC. Ingram (Oxted): "I would like to compliment Mr. Anderson on his paper and Mr. Holroyd for his opening of the discussion. The moderation of their views on this subject were marked and well balanced and I am bound to agree with them. Each case must be judged and treated individually as one finds it. With regard to the time factor, here again I must agree with Mr. Anderson, and I would be most unhappy to leave a case for 24 hours unless it was in the first stages of labour with the os only slightly dilated and the membranes intact. There are cases of torsion of the uterus which after correction, and where the os is still not dilated and the membranes are intact, I would certainly leave for an hour or two because I have experienced good results by doing this, and poor results when I have forced the pace.

"One cannot stress too much the importance of repelling the foetus completely before attempting to correct malpresentation, and on occasions I would recommend lifting the hind quarters of the dam to enable this procedure to be completed. This might appear to be rather incongruous in that the deflected part of the foetus would go farther out of reach but, on the contrary, it frequently partially corrects the malpresentation, and certainly makes it easier to reposition or correct the presentation of the foetus.

"The use of two hands and arms can also be of great help in repositioning the foetus especially in breech cases, one hand manipulating and protecting the point of the hock and the other controlling the foot or fetlock."

The Reply

Mr. Anderson, in reply, referred to the Chairman's last remark that when membranes were broken by the veterinarian organisms were allowed to enter, and pointed out that when those membranes broke naturally, that also allowed organisms to enter, although to a lesser degree perhaps.

One or two matters which had arisen out of the discussion had had a somewhat humbling effect, in that in writing the paper he had forgotten to put down certain fundamentals because he took them for granted. The particular points he had in mind were the very careful examination of the patient to see what one was up against before starting some premature measures, the very obvious point of having a reasonable and moderate approach, of assessing each case on its merits, and dealing with it accordingly, rather than according to any fixed theory formula, and, again, the simple matter of repulsion to assist in manipulation. His only defence for not mentioning the latter was that he hardly mentioned manipulation either!

He found that hydrops amnii was a rare condition, and very few cases were seen nowadays. It was very difficult to deal with, and he found that even if the cow were approaching parturition and one was able to play a waiting game, she nearly always required assistance in delivery. Even then one was usually left with a hopelessly debilitated patient, and he regarded it as being a very serious condition. He agreed that the two-stage operation was probably the best approach, although he had never tried it.

With regard to various abnormal presentations, he agreed that the one he had mentioned with the head straight back was a very rare condition. He had only seen it two or three times, but it was very difficult to manage, purely as a matter of reach. If one were lucky enough to get a rope round the neck with a snare introducer, it was a simple matter of embryotomy; but it was a question of having a long arm.

With regard to a head in the lateral position, there were of course many different degrees of deviation from a slight turn of the head to a complete turn of the head and neck, and there were also many differences in the amount of room available for manipulation. If it were somehow possible to get a grip either in an eye or in the corner of the mouth, it was usually possible to manipulate the head back into place by repulsion on the chest; but each case had to be dealt with individually and often it was necessary to sever the neck.

As to the posterior presentation, that did not come very easily. It was often the stifle joints which held things up, and pulling alternatively on the legs, while repelling the rest of the foetus would very often help. If it would not, then embryotomy was probably essential. With the ordinary breech he liked the two-handed approach if possible, but it was not always that one could do so. It depended on the individual case. If the animal were straining very heavily he used a spinal anaesthetic. If, however,

he felt there was plenty of room and labour was not too severe he endeavoured to manage without.

One speaker referred to carrying out a transverse section and with embryotomy cutting the posterior part in half, in the case of the calf which was caught half way out and stuck. That was all right, but very often they were so tightly jammed it was not possible to get an embryotomy wire round them. After transverse section and evisceration, it was often possible to get a hook round the shaft of the ileum. This could readily be fractured, which allowed of some collapse of the pelvis.

He had not said much about torsion quite deliberately because he did not like torsion and was not always sure what to do about it. A great deal depended on whether or not the foetal membranes were ruptured. If they were not ruptured and it was possible to reduce torsion by various means, then he agreed that time should be given. If, on the other hand, the membranes were ruptured and had been for some time, one had to try to effect delivery once torsion was corrected. Torsion was not very common in his district, and where it occurred it was usually only through about 90°. A good many cases could simply be swung into position. Others responded to rolling. He had not tried hanging up but was convinced that it was the method of choice if conditions were such as to make it possible.

The argument as to whether it was 4 or 24 hours should be avoided. It was a matter of the appropriate approach to the individual case, and undoubtedly great harm could be done by too much hurrying, but even more harm could be done by too much delay. He would stick to his guns and say that 4 hours after the membranes had ruptured was usually the time when some effort must be made to deliver the foetus.

The question of the amount of repulsion which could be used again partially tied up with the time factor. The case to which reference was made in the introduction was one in which he was lucky, and it was easy to repel the calf. He had ample room to move it around; but had the animal been left until the membranes had been ruptured some hours and the uterus had contracted, at that stage any real degree of repulsion would be difficult. The manoeuvrability would have been greatly reduced.

The bowline was the most useful knot of all and it was exactly the same as a sheep-shank used for joining ropes of unequal thicknesses.

He had never possessed the ordinary type of obstetrical gown. The sleeve band is clean and cleansable and is useful to wear one when carrying out a preliminary examination. If it is a simple matter of manipulation, that is enough; but if he had to do any real amount of work he nearly always stripped off.

Several speakers had called him to task over the question of the incision of the cervix. It should have been made clear that there were only certain types of cases where he would consider it—usually the case where the foetus had been dead for some time and labour had been going on for many hours. The foetus was fairly dry and the cervix was not going to relax any more because that stage had passed. In that type of case pressure was applied to the head so that the rim of the cervix was resting on the foetal forehead. A series of small incisions could be made so that when more pressure was put on, it would allow the cervix to split with a high degree of safety.

As to the use of the Aberdeen Angus bull on Friesian heifers, in his view one should sometimes think in terms of prevention. The animals must be considered as patients rather than as purely money getters, and the system could be employed even if purebred calves were more valuable.

It was right to speak of alternate traction on the legs. In his original remarks he was not, perhaps, too clear on that point, but they were really intended to convey that it was towards the same end that efforts had been made. If the direction of traction could be changed periodically, very often it made things considerably better.

With regard to the removal of the foetal membranes, years ago he had the idea that they must be removed on the third day or there would be trouble. He had been to many cows in those days who were in excellent health when he was first introduced to them, but who were sick animals by the time he had finished with them! There was sometimes a degree of adhesion with foetal membrane when separation was almost physically impossible. He liked to go about the third day, and if he found that by simple manipulation separation was occurring, he proceeded. Very often quite a bit of manipulation was done and as one got deeper into the uterus, the adhesions were firmer. That was, in his view, the time to stop. In most cases they were better left alone if they did not come very easily.